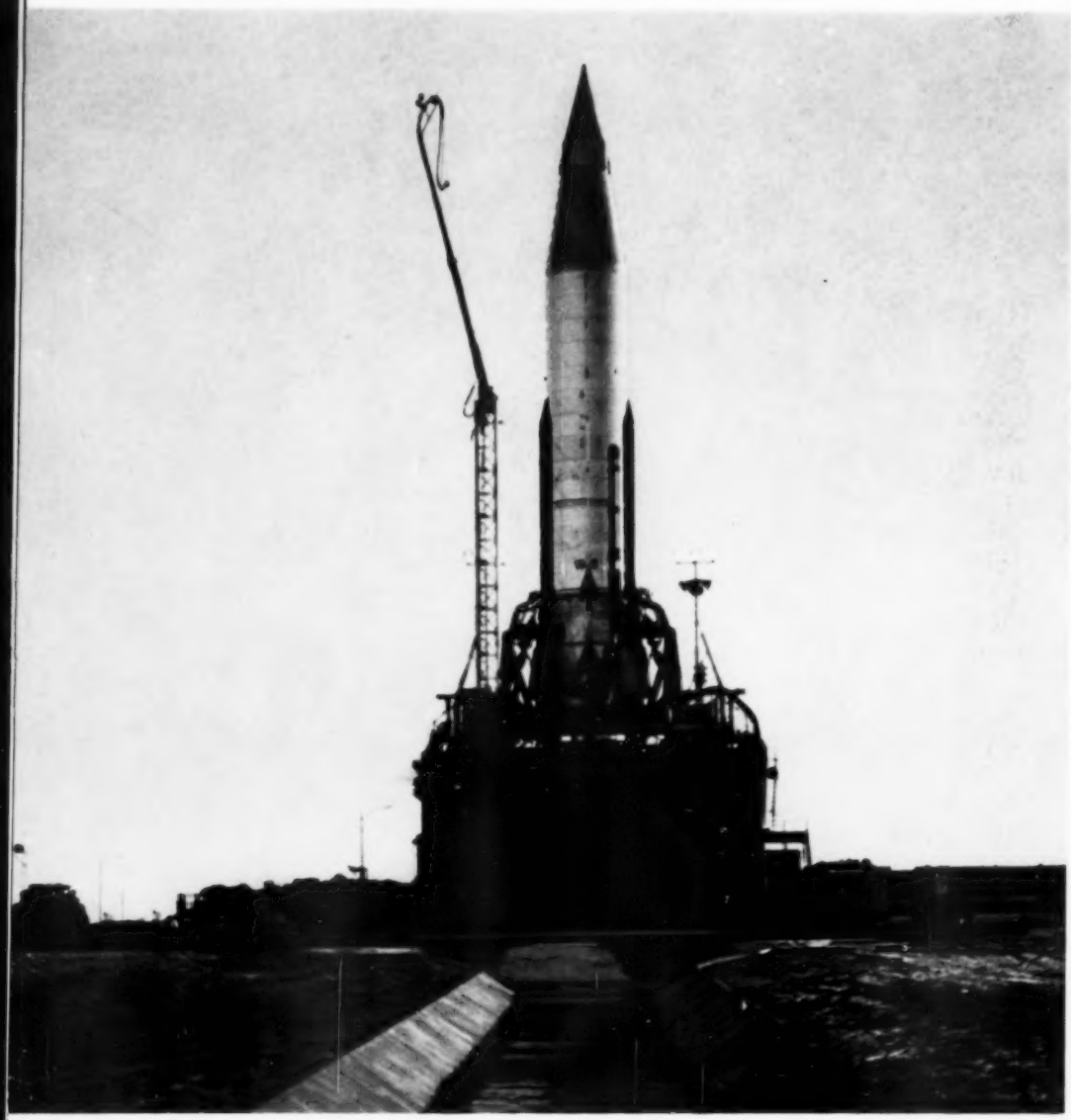
ORDNANCE

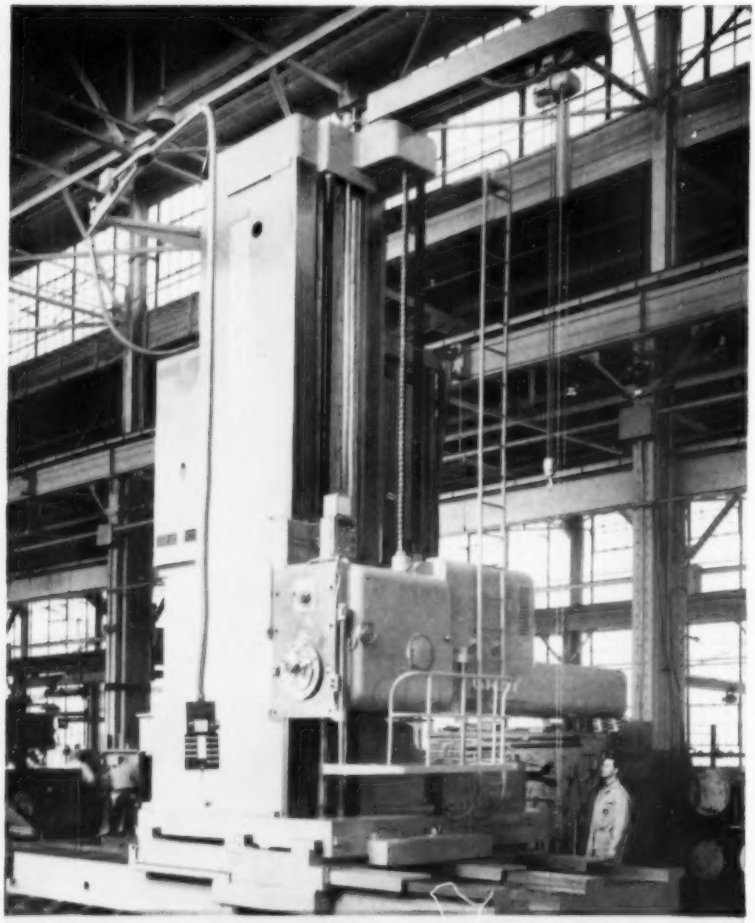
LAND · SEA · AIR · SPACE

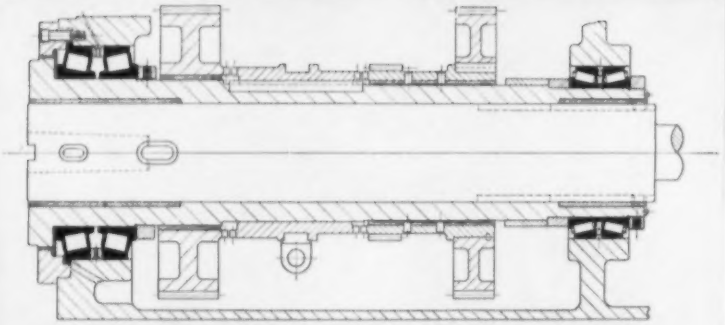


Atlas 10-B Ready for Orbit

MARCH-APRIL 1959

"We switched to TIMKEN® bearings to get greater accuracy and capacity," reports The G. A. Gray Company





How **THE G. A. GRAY COMPANY** mounts the spindle of its new Model 880-FC boring machine on Timken tapered roller bearings to get spindle accuracy, assure precision performance.

HERE'S a precision giant! It's The G. A. Gray Company's new 212½-ton Model 880-FC horizontal boring, drilling and milling machine. Weighing 425,000 lbs., it stands 27 ft. high, spans 76½ ft. in length. It can machine a block of metal 65 ft. long and 15½ ft. high—works with a precision of .00025". Yet one man operates the huge tool. To keep the spindle running accurately, Gray engineers switched to Timken® tapered roller bearings.

Spindle held rigid. Timken bearings hold the spindle in positive alignment. Their tapered design lets them take both radial and thrust loads in all combinations. And full-line contact between rollers and races gives Timken bearings extra load-carrying capacity.

Heavy shocks no problem. Rollers and races of Timken bearings are case-carburized to have hard, wear-resistant surfaces and tough, shock-resistant cores.

Friction virtually eliminated. Timken bearings are geometrically designed and precision-made to roll true. They roll the load. They practically eliminate friction, run smoother, longer with minimum maintenance. For extra quality-control, we even make our own steel. No other American bearing maker does. And you can get Timken tapered roller bearings with maximum runout of 75 millionths of an inch. For all these advantages, specify bearings trademarked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.

This symbol on a product means its bearings are the best.

BETTER-ness rolls on **TIMKEN®** tapered roller bearings

ORDNANCE

LAND·SEA·AIR·SPACE

Thirty-nine Years of Leadership in American Armament

VOL. XLIII MARCH-APRIL 1959 NO. 233

The Cover.—*The Atlas 10-B missile (Project Score), weighing 8,750 pounds empty including a 168-pound payload, was placed in orbit using two booster engines and relayed a message from President Eisenhower, proving the feasibility of satellites as worldwide communication stations (Air Force photo).*

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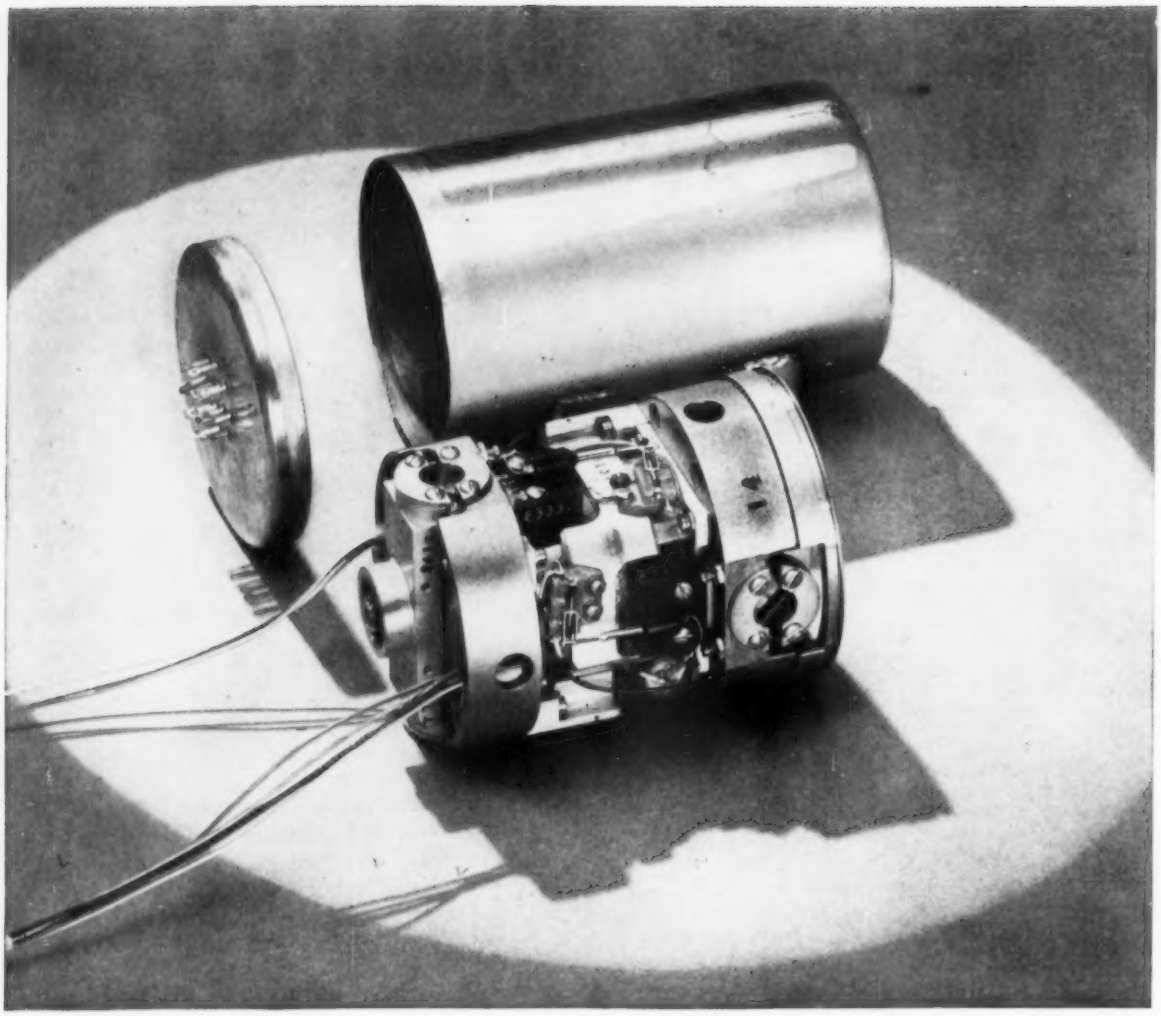
Cincinnati



New Humphrey dual-rate gyros do the work of two units

Now important reductions in the space required for instrument and control packages can be made with the introduction of a new Humphrey rate gyro that replaces two ordinary gyros. The new design utilizes a single motor to drive two separate wheels in one unit. With this new development, it is possible to measure rates about two different axes with an RG-18 Series Gyro or cover two different rate ranges about the same axis with a single RG-20 Series instrument.

RG-18 gyros should find widespread use for applications now requiring two instruments. For example, one unit could be used to measure both pitch and yaw. The RG-20 Series, with its two different rate ranges, may be applied to instrumentation systems where greater accuracy is required. For example, a single unit can be furnished to cover the rate ranges from 0–20 degrees/second and from 0–200 degrees/second. In effect, you expand the dynamic range of your instrumentation system from 100 to 1 to 500 to 1. This expanded scale gives you far greater accuracy.

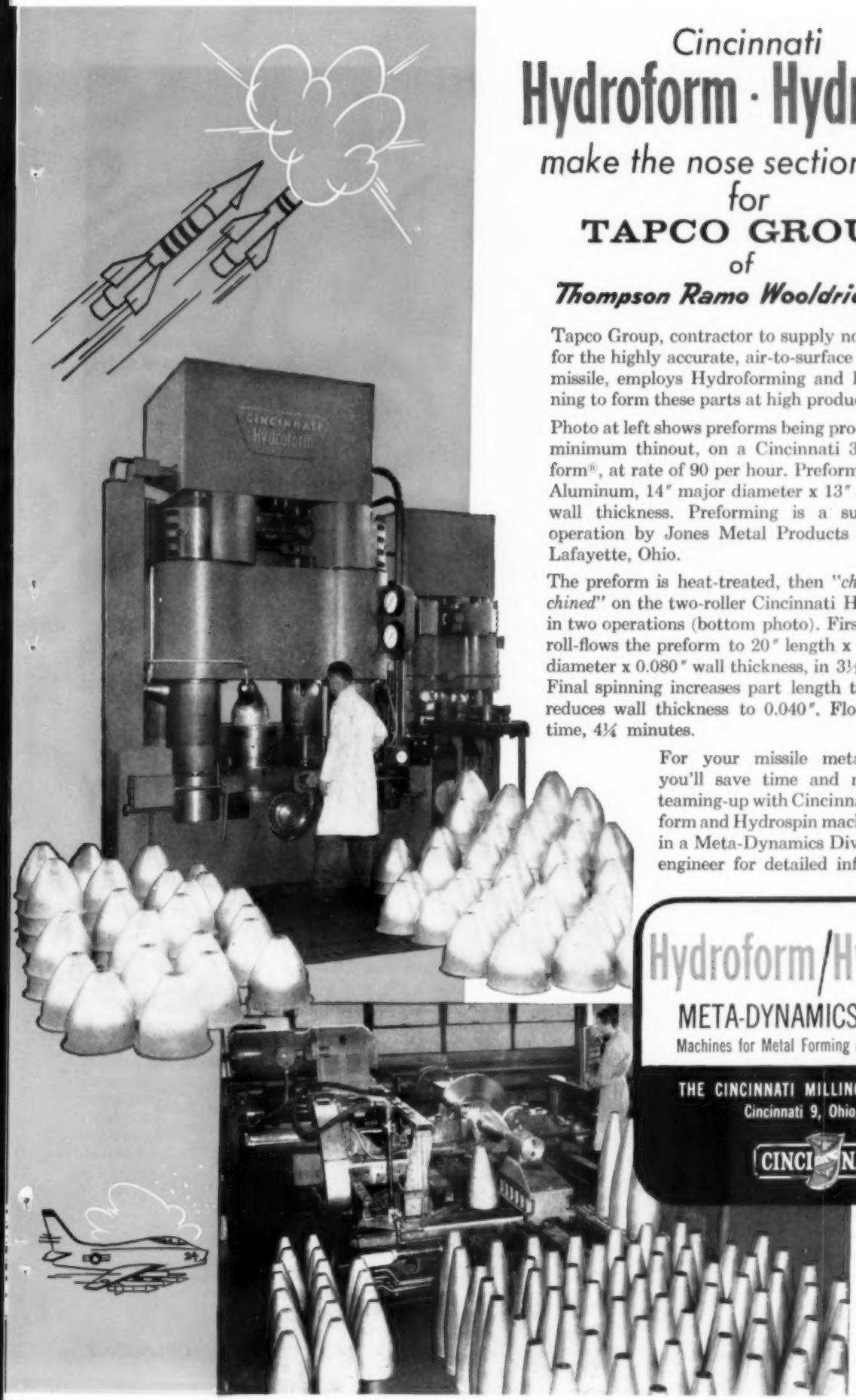
The new rate gyros are built with two independent pick-offs – one for each axis or one for each range. They meet tough environmental conditions, such as temperature from −65°F to 180°F while operating, relative humidity 100%, unlimited altitude and excellent resistance to acceleration, vibration and shock. Phone or write today and let the kind of engineering that developed these new dual-rate gyros go to work for you.

Humphrey Inc.

ELECTRO-MECHANICAL INSTRUMENTS

DEPT. O-39, 2805 CANON STREET
SAN DIEGO, CALIFORNIA

FOR COMPLETE SYSTEMS, SPECIFY HUMPHREY
GYROSCOPES, ACCELEROMETERS, POTENTIOMETERS



Cincinnati Hydroform · Hydrospin

make the nose sections flow for TAPCO GROUP of *Thompson Ramo Wooldridge Inc.*

Tapco Group, contractor to supply nose sections for the highly accurate, air-to-surface "Bullpup" missile, employs Hydroforming and Hydrospinning to form these parts at high production rates.

Photo at left shows preforms being produced with minimum thinout, on a Cincinnati 32″ Hydroform®, at rate of 90 per hour. Preform is of 6061 Aluminum, 14″ major diameter x 13″ deep x ⅛″ wall thickness. Preforming is a sub-contract operation by Jones Metal Products Co., West Lafayette, Ohio.

The preform is heat-treated, then "*chipless machined*" on the two-roller Cincinnati Hydrospin® in two operations (bottom photo). First spinning roll-flows the preform to 20″ length x 12″ major diameter x 0.080″ wall thickness, in 3½ minutes. Final spinning increases part length to 40″ and reduces wall thickness to 0.040″. Floor-to-floor time, 4¼ minutes.

For your missile metalworking, you'll save time and money by teaming-up with Cincinnati Hydroform and Hydrospin machines. Call in a Meta-Dynamics Division field engineer for detailed information.

Hydroform/Hydrospin

META-DYNAMICS DIVISION

Machines for Metal Forming and Heat Treating

THE CINCINNATI MILLING MACHINE CO.
Cincinnati 9, Ohio, U.S.A.

CINCINNATI

FIRST LOW-COST SPACE AGE AIRCRAFT DEMONSTRATES NORAIR SYSTEMS MANAGEMENT CAPABILITY

The twin-jet T-38 –America's first supersonic trainer–aptly demonstrates Norair's capability in systems management. Now in production under USAF contract, the T-38 Talon is the first member of a Northrop-conceived family of lightweight, low-cost space age aircraft.

Soon to follow: a supersonic counterair fighter, the N-156F – first weapon system designed in America for the specific tactical and economic requirements of those free allied nations most vulnerable to enemy attack.

Other important systems management achievements include the USAF Snark SM-62A and the F-89 Scorpion. Norair management of the Snark program produced the free world's first operational intercontinental guided missile – delivered on time and at minimum cost.

In producing America's first nuclear-armed interceptor, Norair's weapon system management of the F-89 was marked by on-time delivery of more than 1,000 units throughout the program's life, and by a significant dollar underrun. A full ten years after its first flight, the Scorpion is still the USAF's most heavily armed interceptor – and a uniquely stable platform for air-launch of atomic rockets.

Norair's cost-proved record of effective management, integrated facilities, and available resources combine to demonstrate outstanding capability as a prime systems contractor.

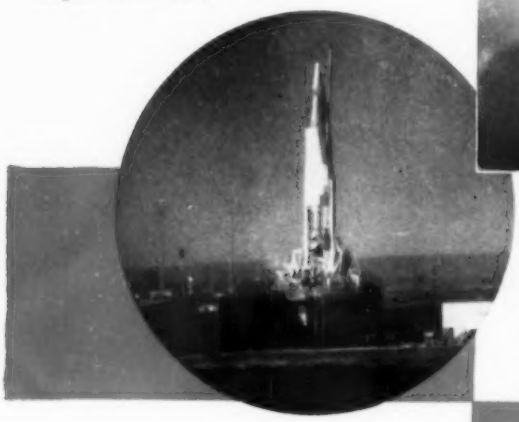
NORAIR *formerly Northrop Division*
HAWTHORNE, CALIFORNIA
A DIVISION OF NORTHROP CORPORATION

KOLLMORGEN Instruments and Systems for missile launching observation

Here are two different Kollmorgen products designed for the missiles field. One is a remote viewing device, the other is used for acquisition and tracking. These are essentially optical instruments, but most Kollmorgen products also include electronic controls and components. Kollmorgen specializes in design and manufacture of a variety of highly precise instruments and systems for both industrial and defense viewing and inspection applications.

We have recently prepared a twenty-four page illustrated brochure which describes our facilities and primary fields of interest. For a copy, please write to Department 223.

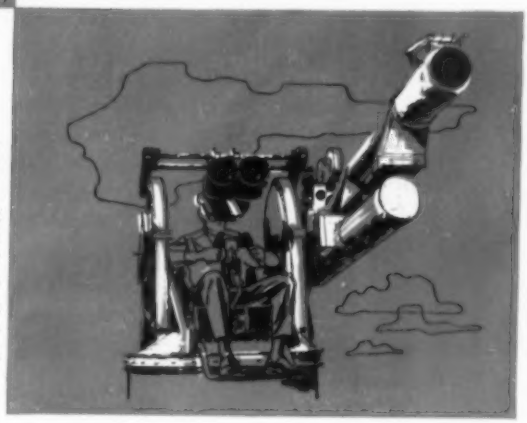
Official USAF photos



At Cape Canaveral, remote viewing of missile firing and static tests is accomplished with Kollmorgen bunker-type periscopes. Bunkerscopes have varying degrees of magnification, show images in true color and allow detailed observation of hazardous operations with no danger to personnel. The photograph at left was taken through a Bunkerscope at low power. For close-up observation and photography, the high power range brings the subject many times closer. Bunkerscopes are easy to operate, need no special care.

for missile tracking

Adapted from a basic Kollmorgen design, Missile Tracking Binoculars form an integral part of an acquisition and photography system which records the performance of tactical air-to-air missiles at China Lake Naval Ordnance Testing Station. These high-power, wide-field instruments enable an operator to spot and track a missile from before the time it is fired until it reaches its designated target.



KOLLMORGEN
optical corporation
NORTHAMPTON, MASSACHUSETTS

In Research—meet three men who get results

Dr. Stuetzer, Mr. Jones, Mr. Demorest work with the electron mirror microscope, a complex instrument which presents a picture of the electrical potential distributions on the surface of matter. The microscope was developed by General Mills for research and development work in solid-state and surface physics. It is the only one of its type in this country.

From high notes to high altitudes, harmony is the keynote of General Mills Research

Meet this harmonious trio of research scientists who spearhead progress in space technology at the Mechanical Division of General Mills. At the piano is Dr. Otmar Stuetzer, whose primary fields are physics and electronics research. Directly opposite him is Les Demorest, manager of atmospherics and measurements research. Sam Jones, standing to the left of the piano, is in charge of the section devoted to materials and mechanics research.

Scientists in our Research Department, like these three, help lay the groundwork for man's conquest of space. They work in harmony with each other and with the creative engineers and precision craftsmen who apply their findings.

Perhaps you can profit from teamwork like this. We'd like to work *with* you.

NEW BOOKLET RIGHT OFF THE PRESS tells and shows the many ways we serve industry and the military. Write for your copy. Address Dept. AA-2

MECHANICAL DIVISION General Mills

1620 Central Avenue • Minneapolis 13, Minnesota

To wider worlds—through intensive research • creative engineering • precision manufacturing

BURROUGHS COMPUTATION GUIDES ATLAS INTO ORBIT

Back of the history-making Burroughs computation that guided the Atlas Satellite into orbit—and that also guides the big bird to its earthbound targets—lies a dedication to continuing advancement. Coming: even greater developments geared to the mounting challenge of the space age.

Burroughs Corporation

"NEW DIMENSIONS | in computation for military systems"

THE FACTS ABOUT MAGNESIUM AVAILABILITY

Prospect: Abundant, readily obtainable quantities in the U. S. of the lightest structural metal . . . in every usable form for both military and civilian use.

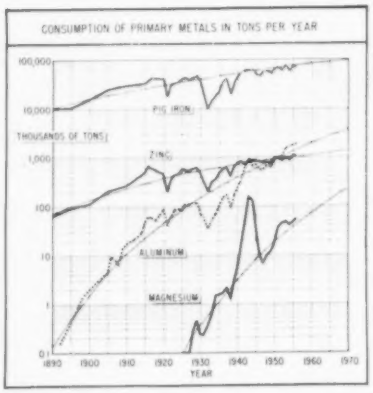
MAGNESIUM, the lightweight metal from the sea, lends itself to a host of structural and non-structural applications. The future indicates an ever increasing usage of magnesium and its alloys as more and more industries become aware of its many desirable characteristics.

In addition to being lightweight, magnesium has a high stiffness-to-weight ratio, unexcelled machinability, the ability to be worked by all common methods, and stability in many atmospheres. There are conventional alloys for use at normal temperatures and special alloys for use in the missile and aircraft field at temperatures up to 700°F. and above. Many types of casting, extrusions, and rolled products can be produced from magnesium alloys.

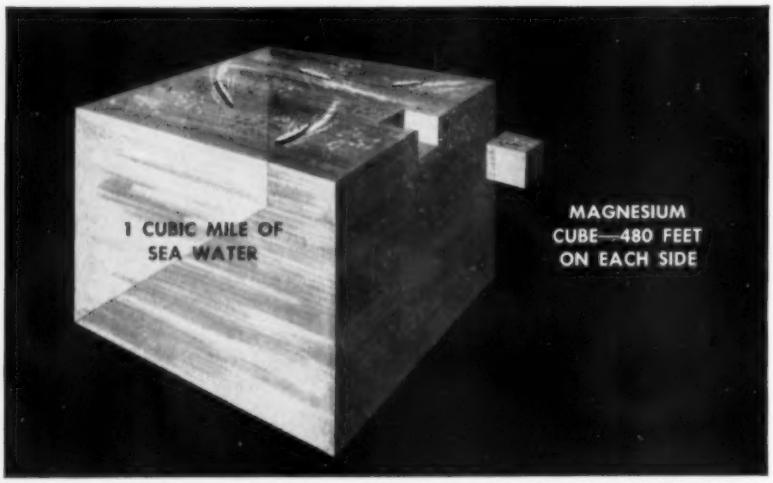
What about the availability of magnesium? Is there raw material in sufficient quantities to satisfy foreseeable requirements? Are producing capacities ample for increased demand?

The answer to these questions is an emphatic "yes"! The sources of magnesium are, by any standard of measure, inexhaustible. From the standpoint of accessibility, as well as quantity, magnesium is the most readily available of all metals.

As you know, magnesium is "mined" from the ocean, as well as the earth. One cubic mile of sea water contains about six million tons of the metal. There are approximately 320,000,000 cubic miles of sea water in the world, and the entire coast line of the continental United States can be considered as one immense source of supply. Easy to see why magnesium supply is termed "inexhaustible" in the most conservative quarters. And it is quite practical and economical to recover magnesium from sea water. Dow has been doing it for seventeen years.



MAGNESIUM CONSUMPTION in the U. S. has increased at a rapid rate since the Twenties.



ONE CUBIC MILE of sea water contains enough magnesium to build a solid cube 480 feet on each side, or, a bar one foot by one foot over 20,000 miles in length, enough to circle the earth at the latitude of San Francisco.

Perhaps less dramatic, but just as important, is the fact that more than adequate supplies of magnesium are to be found in dolomite, magnesite and other magnesium mineral deposits. These are widely distributed in nature's storehouse, a large quantity being found on the North American continent.

And what about manufactured forms of the world's lightest structural metal? Magnesium is available today in every usable form: ingot, sheet, plate, castings, forgings, and extrusions. There are some seventy sand and permanent mold foundries in all parts of the nation. Over one hundred metal working plants fabricate magnesium products and parts.

Looking toward future needs, Dow's production facilities can supply quantities of ingot and fabricated magnesium well in excess of present demand. The ingot producing plants in Texas and the mill products plant at Madison, Illinois, have a capacity of thousands of tons of magnesium products per year.

FOR MORE INFORMATION about magnesium, contact the nearest Dow Sales Office or, write THE DOW CHEMICAL COMPANY, Midland, Michigan, Department 1481DF3.

THE DOW CHEMICAL COMPANY · Midland, Michigan

DOW

New NASHVILLE Division

Structures for tomorrow's aircraft and missiles

To make ready for the future, Avco Manufacturing Corporation has created a new division at its Nashville plant devoted to design, development and production of aircraft and missile structures and assemblies.

Avco's new Nashville Division (formerly a part of the Crosley Division) boasts an enviable 17-year record of building components for some of the country's most important aircraft, including the B-52, B-47 and B-36.

Today it produces components for these aircraft:

Convair 880 jet airliner—horizontal and vertical stabilizer; wing tip, leading and trailing edges and flaps.

C-130 Hercules transport—complete empennage.

F-102 Delta Dagger—wing trailing edge.

F9F Cougar—horizontal stabilizer, flaperons and flaperettes.

Looking ahead, the Nashville Division has prepared itself to contribute to the Mach 3 aircraft and Mach 10 missiles that soon will go into production as part of the nation's defense effort.

The Nashville Division's skilled personnel have demonstrated their know-how in producing Avcomb, contoured stainless steel honeycomb panels. They long ago proved themselves in the production of aluminum honeycomb structures, and other advanced manufacturing techniques, such as metal bonding and chemical milling.

Avco/Nashville:
proven . . . ready for tomorrow

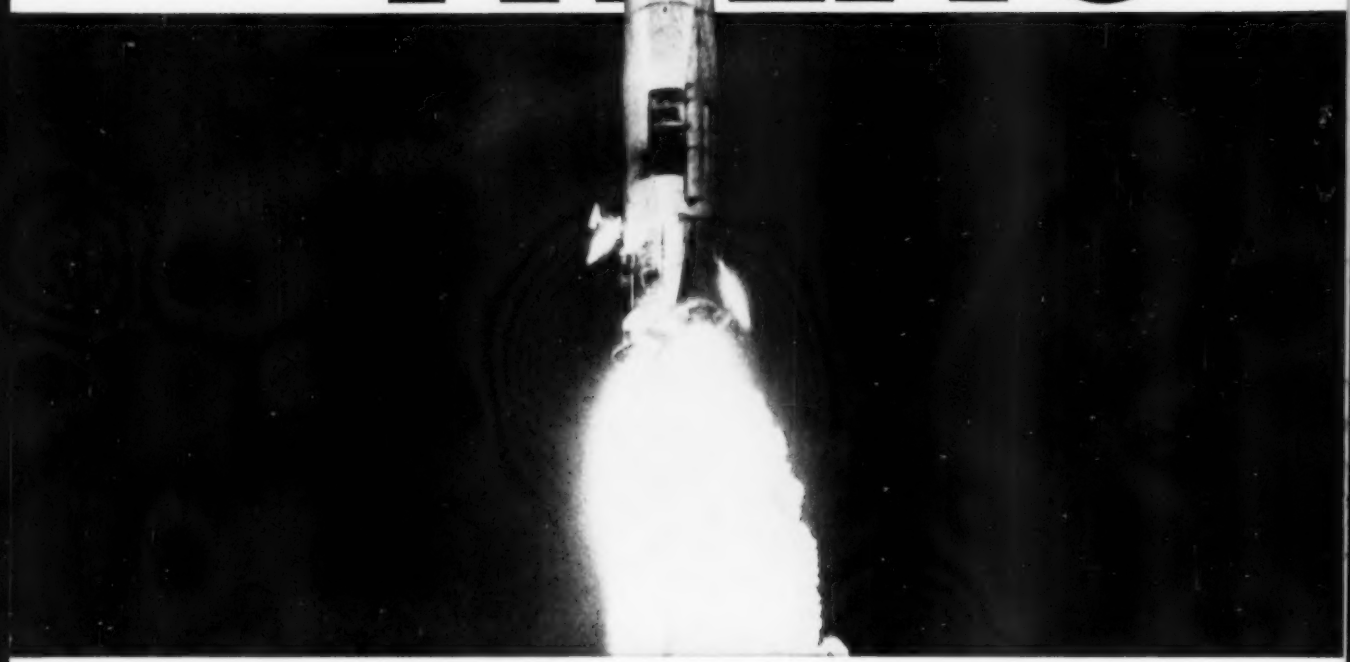
For further information, write: General Marketing Manager—Structures, Nashville Division, Avco Manufacturing Corporation, Nashville, Tennessee.

Avco / Nashville

Preserver of Peace . . .

ATLAS

Air Force "Sunday Punch"



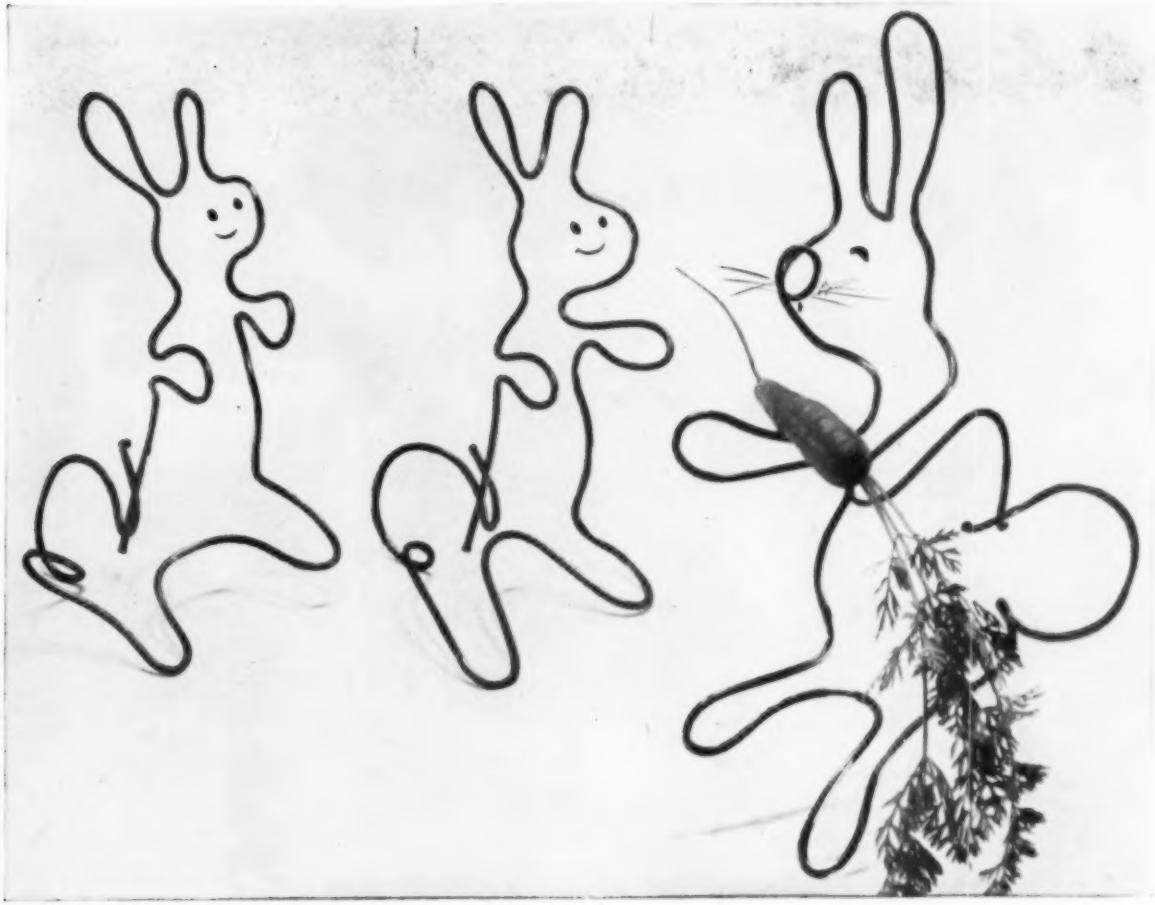
Boosted into space by the fiery thrust of three huge rocket engines, the seven-story Atlas intercontinental ballistic missile roars upward from its Cape Canaveral launching pad. Quickly it sheds the frost encrusting the liquid oxygen tank and races to its predetermined destination in the far reaches of the globe. In its size and range and capability, the Air Force Atlas is a commentary, for all the world to heed, of the necessity to maintain the peace. RCA's Missile and Surface Radar Department has been privileged to design and develop ground check-out, launch control and cabling equipment as a major subcontractor to Convair (Astronautics) Division of General Dynamics Corporation, the Atlas prime weapons systems contractor.

RADIO CORPORATION of AMERICA

DEFENSE ELECTRONIC PRODUCTS

CAMDEN, N. J.

Tmk(s) ®



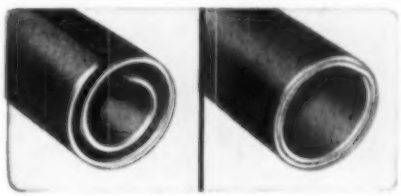
There's practically no limit to the things Bundy can mass-fabricate

. . . and we do it with Bundyweld, the stronger, safer steel tubing that's made for easy bending

SKILLED Bundy® technicians turn out many a strange shape—each to its exact tolerances. At Bundy, you get precision *in mass-fabrication.* Jigs, fixtures—even machines—are designed by Bundy specifically to cut customers' unit costs.

You get Bundyweld® Tubing, too. An exclusive process (right) gives it unique physical properties. So Bundyweld—master of volatile refrigerants and high-pressure brake fluids—has become the safety standard of two major industries.

Bundy engineers will design your tubing part, or work with you on its development. When we fabricate your parts, you can count on careful packaging, on-time delivery. Bring *your* tubing problem to Bundy. Contact us today!



Bundyweld is the only tubing double-walled from a single copper-plated *steel* strip, metallurgically bonded through 360° of wall contact for amazing strength, versatility.

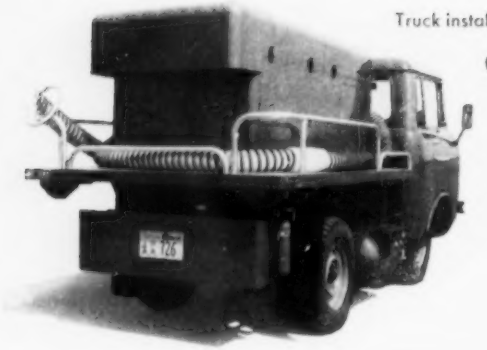
Bundyweld is lightweight, uniformly smooth, easily fabricated. It's remarkably resistant to vibration fatigue; has unusually high burst strength. Sizes up to ⅝" O.D.

There's no real substitute for Bundyweld Tubing

BUNDY TUBING COMPANY

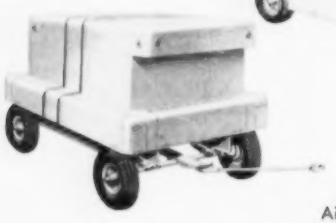
DETROIT 14, MICHIGAN

WORLD'S LARGEST PRODUCER OF SMALL-DIAMETER TUBING. AFFILIATED PLANTS IN AUSTRALIA, BRAZIL, ENGLAND, FRANCE, GERMANY, AND ITALY



Truck installations supply pneumatic power for main engine starting, cooling and heating, electrical power for commercial jet powered airliners.

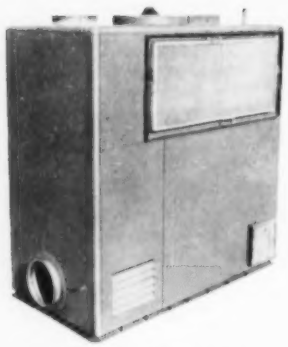
Dual carts for main engine starting, air conditioning and electrical power for military aircraft



Reliable and versatile ground support

AiResearch MA-1A trailer for starting military aircraft. Nearly 2,500 in the field.

Air transportable pod for engine starting, cooling of electronic equipment and pre-flight checkout for military aircraft.



Lightweight Freon system, usually installed in a van or trailer, for cooling electronic equipment in support of missiles.

AiResearch ground support equipment is tailored to meet turbine powered aircraft and tactical missile requirements. Lightweight, compact units can be designed to specific configurations or installed on standard vehicles.

Heart of the lightweight ground support systems are AiResearch gas turbine compressor power units. Capable of delivering both electrical and pneumatic power, nearly 8,000 of these units are operating successfully and dependably in the field.

Support services can include: main engine starting, pressurization and air conditioning of cabins and compartments, missile pre-flight check-out, removal of snow and ice from aircraft and equipment, supply of DC or AC electrical power at any required frequency, and low pressure, high flow air for operation of a variety of actuation systems. The units have push-button starting and operate without delay under all weather conditions.

The world's largest producer of lightweight turbomachinery, the AiResearch Manufacturing Divisions are prepared to assume complete systems management responsibility for your ground support requirements.

ENGINEERING REPRESENTATIVES: AIRSUPPLY AND AERO ENGINEERING, OFFICES IN MAJOR CITIES

THE GARRETT CORPORATION

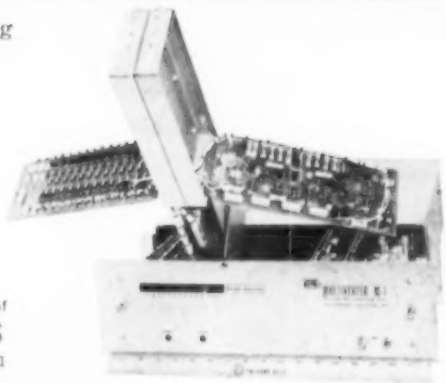
AiResearch Manufacturing Divisions

Los Angeles 45, California • Phoenix, Arizona

Systems, Packages and Components for: AIRCRAFT, MISSILE, ELECTRONIC, NUCLEAR AND INDUSTRIAL APPLICATIONS

MULTIVERTER CONVERTS "BEEP" TO NUMERAL
The MULTIVERTER is the first solid state, high-speed digital⟷analog conversion system accurate to .01%. It is also the first converter to solve various complicated arithmetic problems, including square root, during the process of conversion. A typical MULTIVERTER application is its use in converting analog data received from the orbiting "Explorer." Information telemetered from the satellite and recorded on magnetic tape is converted to numbers by the MULTIVERTER and fed into a digital computer. The result: usable and accurate new knowledge of outer space.

ENGINEERING BEYOND THE EXPECTED
The need for highly accurate measurement in an accelerating technology called for a solid state converter with an accuracy of .01% and a speed of four microseconds per bit. The MULTIVERTER and related accessories resulted. One immediate application has been the interconnection of Packard Bell's TRICE, the first incremental differential analyzer to operate in real time, with various analog systems. Other applications include Missile Impact Prediction, Coordinate Conversion, Orbit Prediction and Solid State Automatic Checkout Systems.



Packard Bell Computer Corp., a subsidiary of
PACKARD BELL ELECTRONICS
12333 W. Olympic Blvd., Los Angeles 64, Calif., BR 2-2171

How Lockheed helps conserve defense dollars:

The missile with 9 lives

The U.S. Army's new Q-5 *Kingfisher* was designed by Lockheed's Missile Systems Division to provide our mighty arsenal of ground-to-air missiles with a realistic test of marksmanship—against high-altitude targets moving at supersonic speeds over 1500 miles-per-hour.

The *Kingfisher* is 38-feet long, 20-inches in diameter, has a 10-foot wingspan and weighs more than 7600 pounds. As it flashes across the skies it electronically simulates any desired size and type of "enemy" plane or air-breathing missile.

The *Kingfisher's* electronic Firing Error Indicator instantly and accurately tells ground controllers whether missiles fired at it are "hits" or "misses"—and automatically evaluates each missile's angle-of-attack, miss-distance, and other highly important technical data.

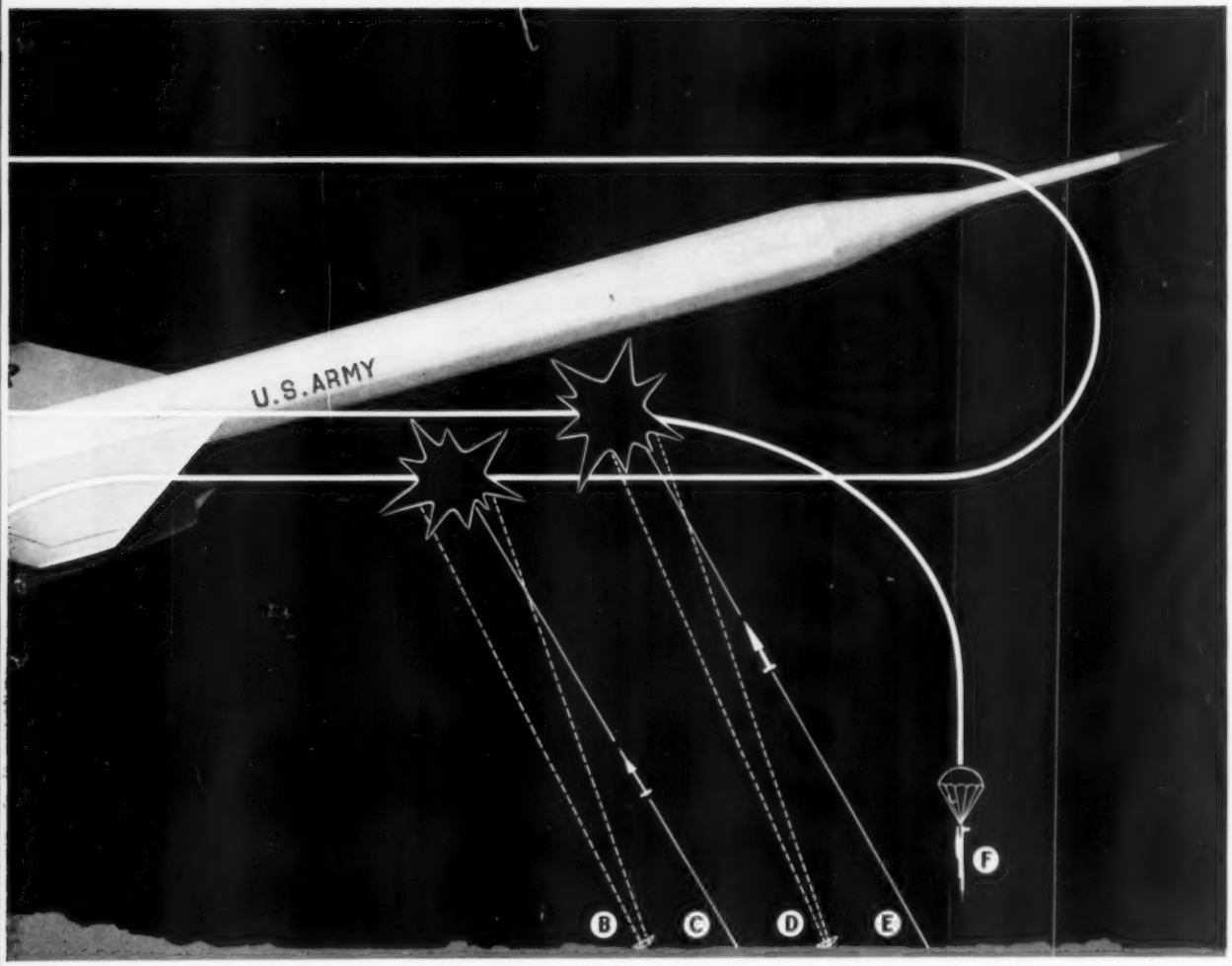
Undamaged by "hits" scored on its electronic image, the Q-5 *Kingfisher* is parachute recovered after each flight.

This Lockheed-developed "missile with 9 lives" will enable the U.S. Army to achieve hitherto impossible proficiency in missile marksmanship against supersonic targets.

Q-5 is dropped by plane at 35,000 feet ((**A**) in diagram). Then its twin rockets ignite, propel it to speeds required to operate its ramjet engine.

Q-5 is detected as "enemy" by ground radar (**B**), and its speed, altitude, and course are fed into fire-control computer of Nike battery.

Missiles fired at Q-5 are like those used in wartime—but lack high-explosive warheads. Nike missile (**C**) scores "hit" on Q-5's electronic image.



Above: Entering oval flight pattern, Q-5 attains speeds over 1500 mph. Second ground radar **(D)** and missile-launching battery **(E)** practice their marksmanship until Q-5 *Kingfisher's* fuel supply is exhausted.

Left: Landing on its nose-spike in a remote, uninhabited area, after floating down by parachute **(F)**, the Q-5 is recovered by U.S. Army ground crews—to be refueled and refitted for future flights.

LOCKHEED

LOCKHEED AIRCRAFT CORP., MISSILES AND SPACE DIVISION

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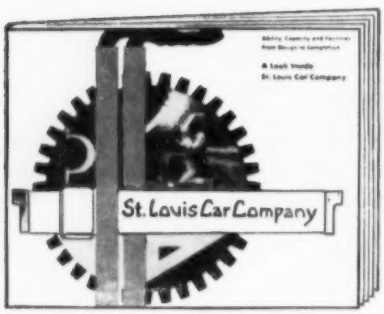

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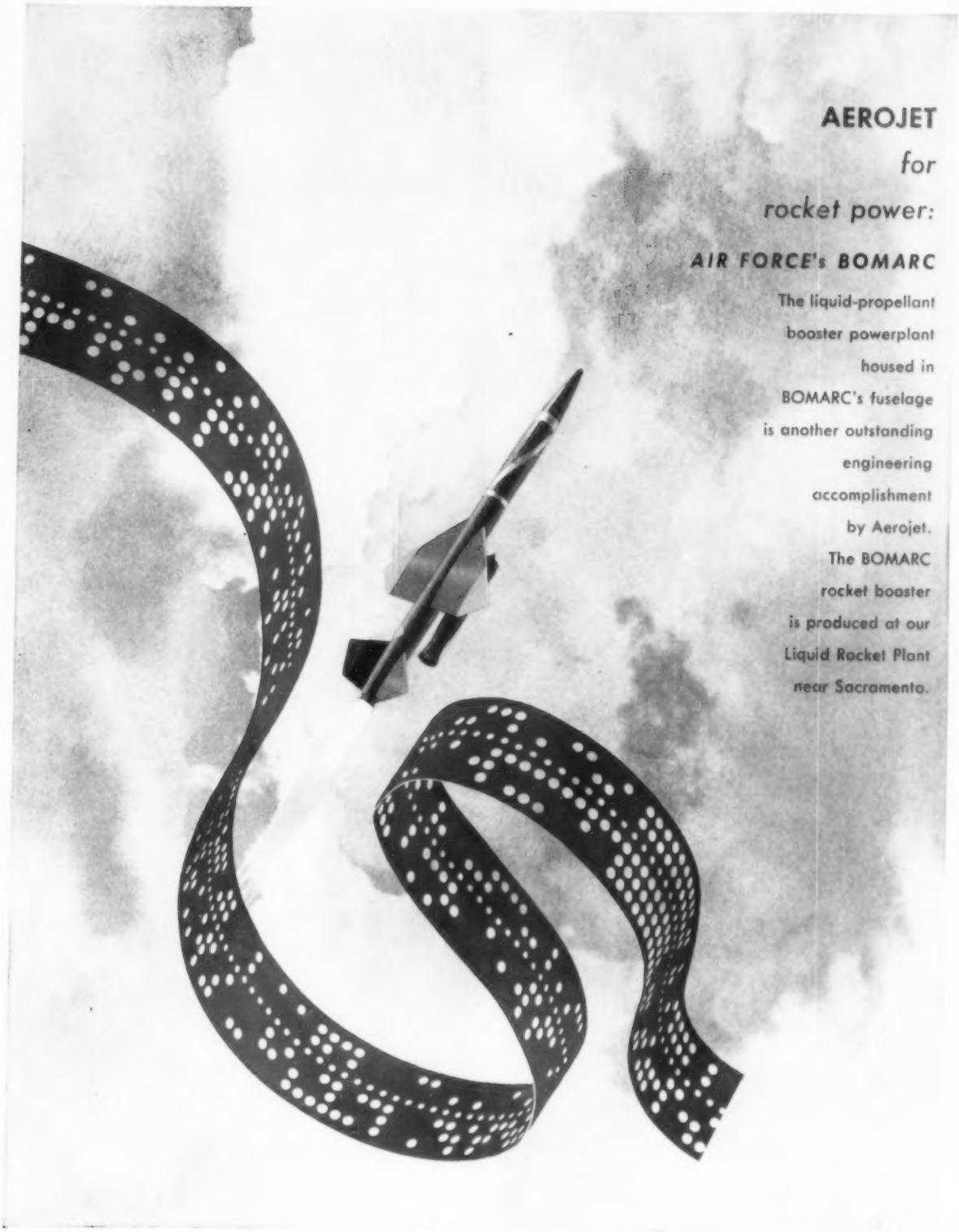

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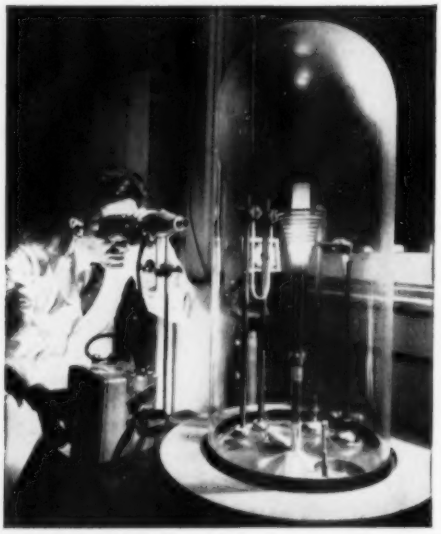
CAPABILITIES FOR DEFENSE

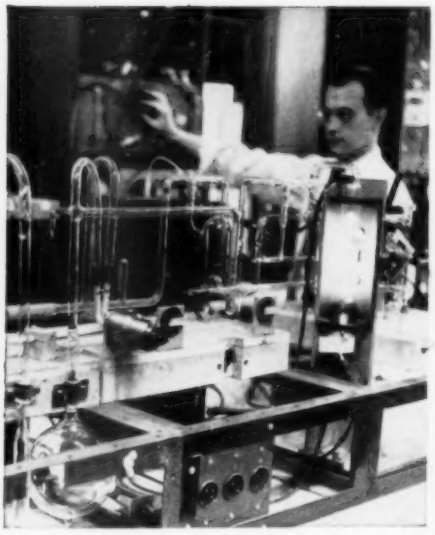
Westinghouse is spending $185 million for research and development in 1959

HERE ARE SOME CURRENT PROJECTS...

HIGH TEMPERATURE ELECTRICAL INSULATION. Effective for long periods at 500° C—eventual applications to 1000° C now contemplated. Demonstration motor shown above is running red hot. ***Aircraft Equipment Department, Materials Engineering Departments, and Research Laboratories***



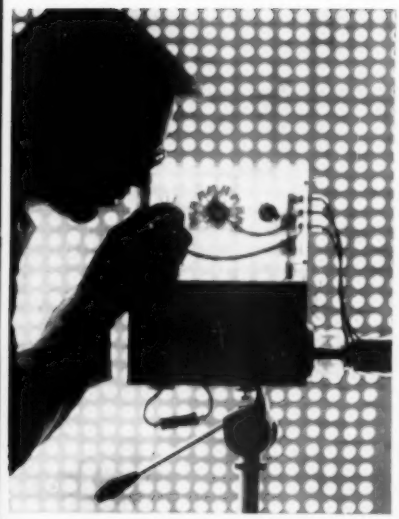
SPECIAL METALS. Westinghouse spearheads research in refractory alloys with one of the country's largest programs in special metals. Westinghouse is nation's principal supplier of a number of special defense-application metals. ***Materials Manufacturing Department, Aviation Gas Turbine Division and Lamp Division***



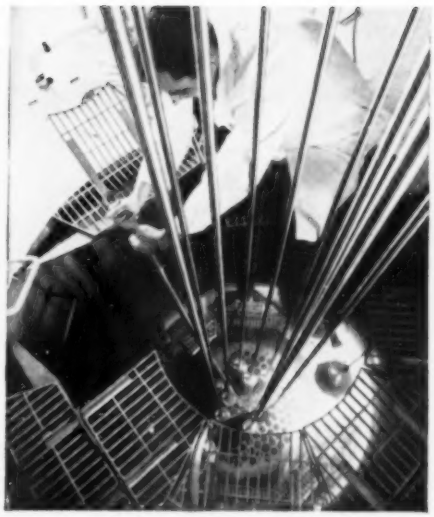
HIGH-VACUUM RESEARCH. Extensive high-vacuum research conducted since 1947. Current areas of investigation include electrical and chemical pumping in ultra high-vacuum range and component development for large high speed pumping systems. Results being applied in advanced electronic device development. ***Air Arm Division and Research Laboratories***

UNDERWATER SONICS. Current Westinghouse projects being conducted in laboratories and at sea are investigating various types of "scatterers" and their effect on the underwater transmission of sound. Also under development: acoustical torpedo controls and an acoustical mine identification system. ***Ordnance Department and Research Laboratories***

NON-ROTATING 360° RADAR ANTENNA. Only the feed point moves. Principle involved will permit economical construction of very large high gain scanning antennas. Application of inflation techniques will permit lighter-weight long-range air-transportable radar. Working models already built and evaluated. ***Electronics Division and Research Laboratories***

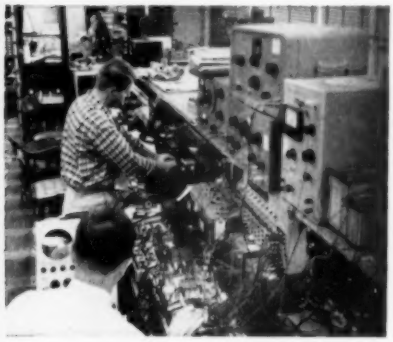


LIGHT AMPLIFICATION, through electron bombardment induced conductivity. Extremely sensitive. Principle especially useful for satellite reconnaissance devices. Efficient working models have been developed. ***Electronic Tube Division, Astronautics Institute and Research Laboratories***

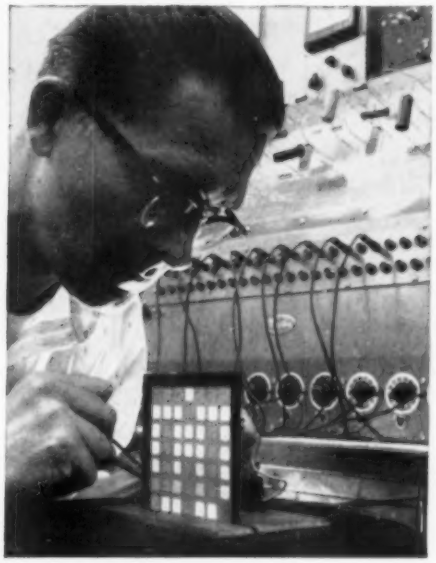


NUCLEAR RESEARCH. At the Westinghouse Testing Reactor, engineers are preparing high intensity radiation tests on a wide range of materials to determine their structural, chemical, and nuclear stability. This is a necessary prelude to using these materials in certain atomic power applications now under development. ***Atomic Power Department***

INFRARED research projects include: *thermal imaging* — working models in advanced development; *ultrasensitive doped crystal detectors* — advanced test models; *photo-electric magnetic detection* — working model. ***Air Arm Division, Semi-Conductor Department, Materials Engineering Departments, and Research Laboratories***

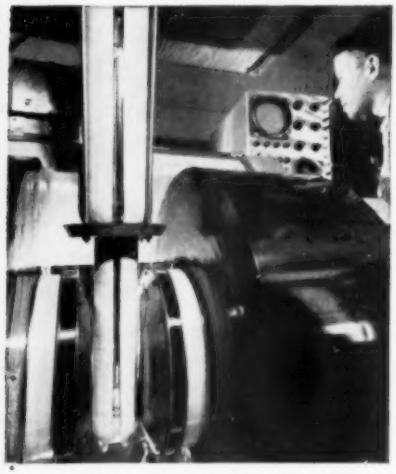


PULSE-DOPPLER RADAR is in advanced development in three major areas of application at Westinghouse. Research is continuing to open up new potentials. Westinghouse is the acknowledged leader in this field. ***Air Arm Division***



NEW DATA DISPLAY DEVICES. Electroluminescent cells, individually controlled, form flat picture. Model has oversize cells for demonstration; latest techniques produce cells only 1/16" across. Similar tote board display, capable of high-speed read-out of digital inputs, in production. Both devices can be erased instantly or retained and studied for long periods. ***Electronics Division, Rayescent Lamp Department and Research Laboratories***

THERMOELECTRICITY. Westinghouse recently developed the first efficient material to produce electricity directly from heat at high temperatures (1100° C). In addition, other thermoelectric material under development can be used for cooling purposes, including very light-weight applications. Forty Westinghouse scientists now on this project. ***Materials Engineering Department and Research Laboratories***



LOW-NOISE MICROWAVE AMPLIFICATION. Westinghouse scientists have developed various low-noise solid-state amplifying devices, both MASER and non-linear reactance types. Progress in recent years was speeded by prior years of research in low-temperature and solid-state physics. ***Air Arm Division and Research Laboratories***

For information on these and other research projects, write to Mr. E. W. Locke, Director, Customer Relations, Westinghouse Defense Products Group, 1000 Connecticut Avenue, N.W., Washington 6, D. C.

Westinghouse

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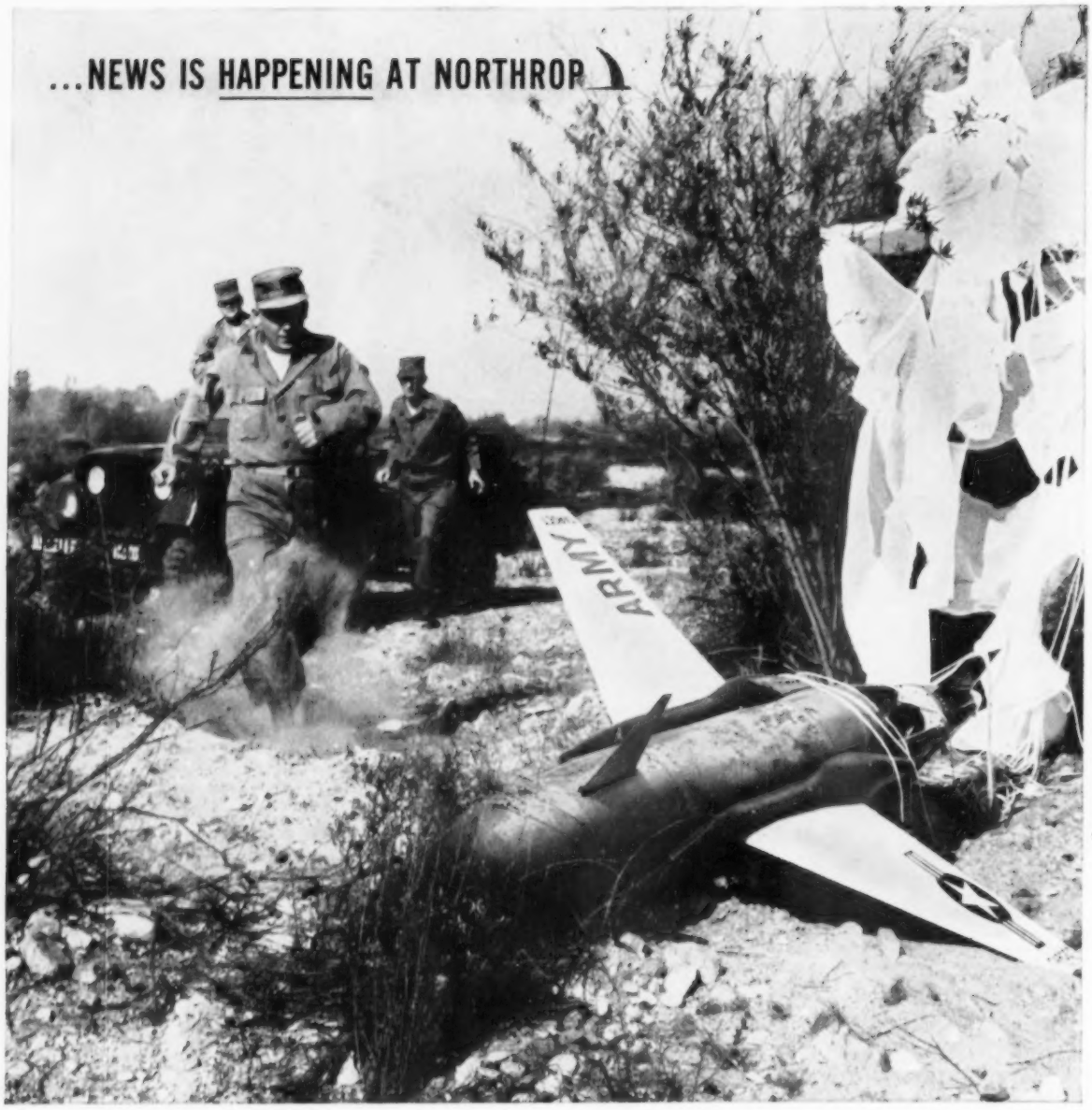


RADIOPLANE RP-76 SIMULATES NEAR-SONIC ENEMY ...ARMY MISSILEMEN SCORE HIT IN FIRST FIRING!

Place: Red Canyon Range, New Mexico. Time: minutes after an RP-76 high-altitude air-launching by Radioplane personnel. Event: Army missilemen sight RP-76 simulating an enemy weapon system approaching at Mach 0.9. They fire—for the first time against an RP-76—score a direct hit.

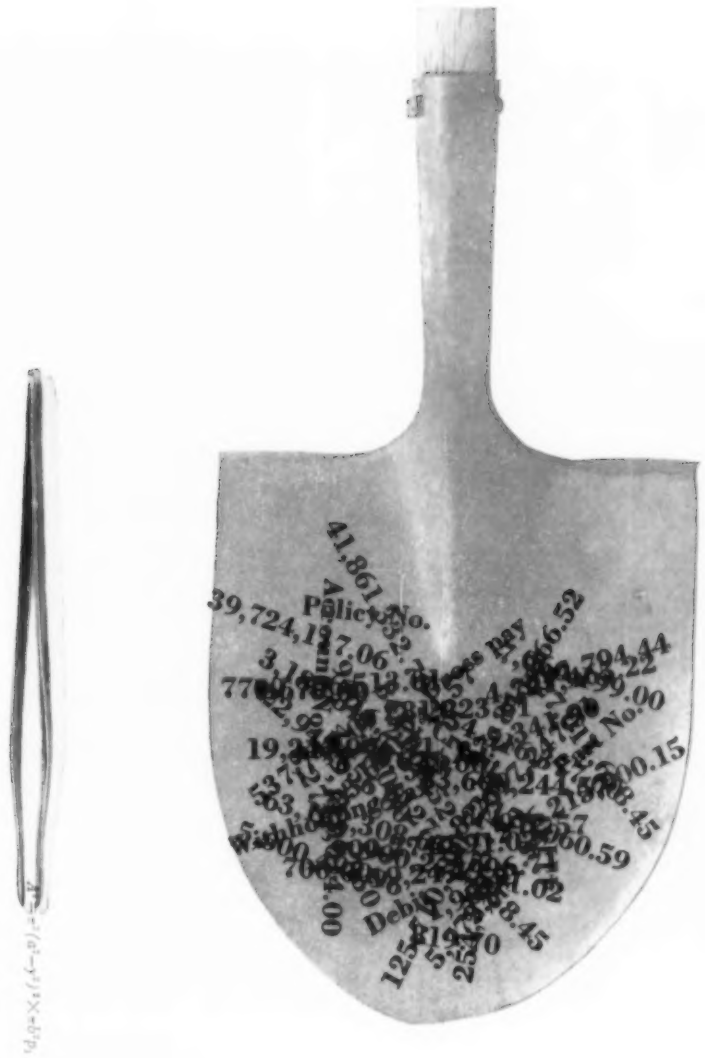
Responsible: the men of Battery C, 1st Missile Battalion (Nike-Ajax), 56th Artillery, U.S. Army Defense Command; the men of Radioplane's contractor-operated flight service program, backed by the more than 2,500 Radioplane drone specialists who designed and produced the RP-76.

This Army-Radioplane achievement typifies the result of Radioplane teamwork with all of the U. S. Armed Forces. Other current examples in development: the supersonic USAF-XQ-4A weapon evaluation target drone and the U.S. Navy's XKD4R-1 rocket target, two more members of Radioplane's complete drone family.

RADIOPLANE

VAN NUYS, CALIFORNIA, AND EL PASO, TEXAS

A Division of Northrop Corporation



does both jobs equally well—Burroughs 205 Computer

From the sequential solution of long scientific problems to the mass processing of business data, the versatile Burroughs 205 electronic data processing system is ideally suited to a wide range of applications. Top capacity and speed in the medium price class, complete choice of input-output media, vast external magnetic tape storage. At work in many varied industries, the 205 has proven its superior dollar-for-dollar value. Its flexibility lets you grow into a larger Burroughs system as your needs increase. Burroughs extensive support program provides on-the-spot technical assistance for an advanced and complete line of data processing systems...all currently in production. Write for 205 brochure. ElectroData Division, Pasadena, California.

Burroughs Corporation

"NEW DIMENSIONS/in electronics and data processing systems"

MISSILE COMPONENTS Bulova safety and arming systems protect ground, air and sea crews from load to launch, then take over in flight. Safety factor of one in a million is specified and reliably delivered by Bulova's precision production facilities. Powder-driven gyros and fuzing systems are among other Bulova developments for 18 key missiles.

AIRCRAFT INSTRUMENTS Bulova's new Servo Altimeter assures maximum reliability through unprecedented sensitivity, accuracy and repeatability. At 40,000 feet, it detects 4-foot changes . . . is correct to 40 feet. Safety is improved in traffic control and flight over difficult terrain. As a control instrument, it is readily adaptable to guided missiles.

Bulova reliability helps to solve today's most challenging problems

For more than 80 years, Bulova has charted new courses in the area of reliability.

Milestones along the way are the electronic and electro-mechanical devices created by the Bulova capability—the uncommon blend of pioneering vision and precision production experience.

These Bulova developments, distinguished by their advanced design and consistent high performance, help our nation's defense and industry stake solid claims on the frontiers of science and space.

The high degree of Bulova reliability prevails from concept to mass production. For assistance with your systems and components problems, write: *Department G.I.S. 3, Bulova Park, Jackson Heights, New York.*

BULOVA
watch company

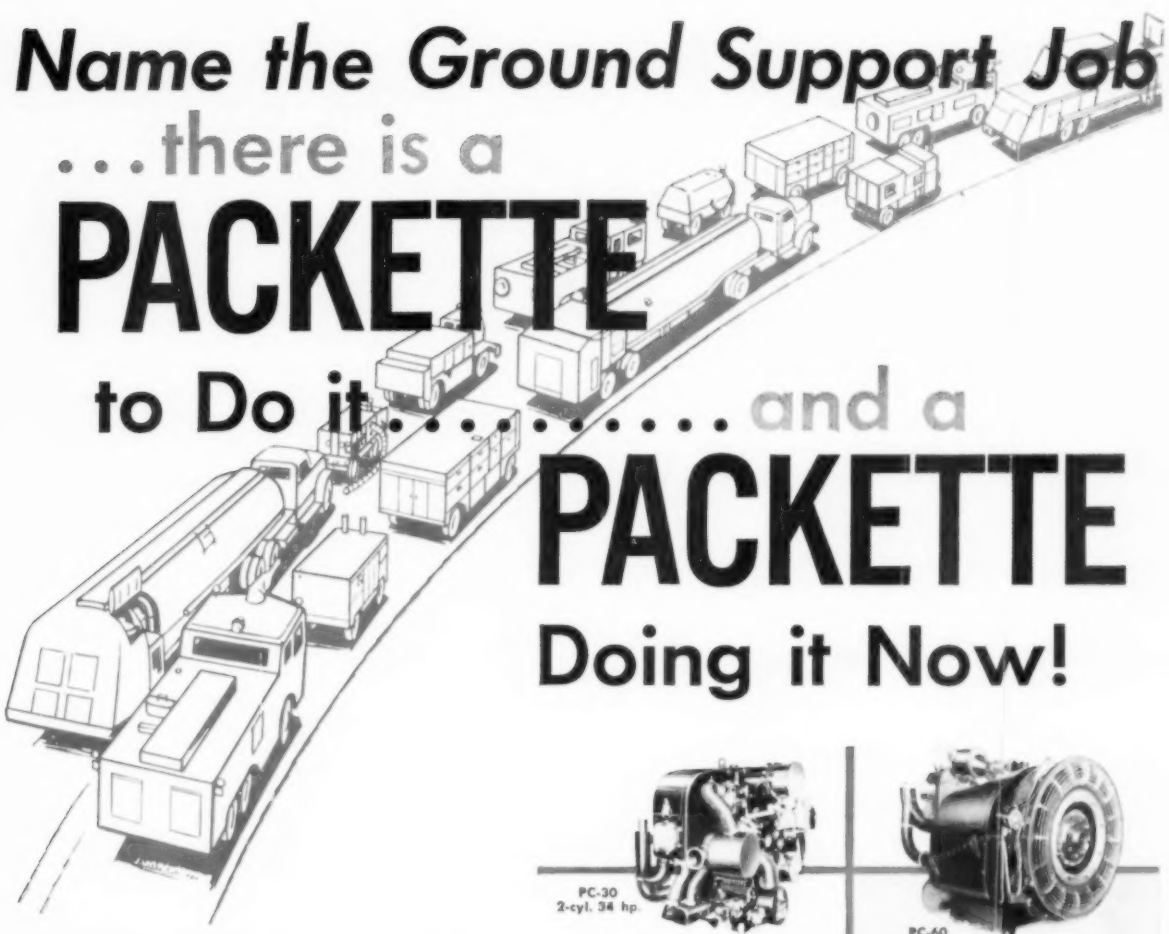
BULOVA RESEARCH AND DEVELOPMENT LABORATORIES, INC.

INFRA-RED COMPONENTS Bulova infra-red cells are designed to unerringly guide Sidewinders to target. Bulova-improved production processes increase yield and product reliability. Other infra-red developments include filters, reticles and thermistor bolometers, as well as advanced research in mosaic and lead selenide cells.

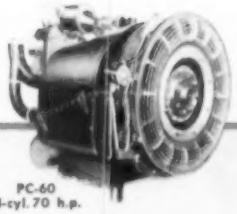
PHOTOGRAPHIC SYSTEMS Bulova's new high performance 70mm recon-camera features 8 frame/sec. and pulse operation . . . vibration-free exposures to 1/4000 sec. From the smallest 16mm gun camera ever built to units of 9x18" format size, Bulova developments include optical, data recording and instrumentation, and special sequence cameras.

Name the Ground Support Job

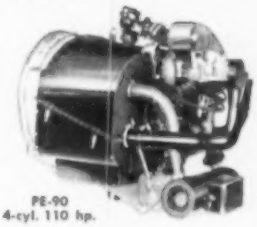
...there is a PACKETTE to Do it.....and a PACKETTE Doing it Now!



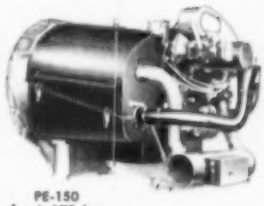
PC-30
2-cyl. 34 hp.



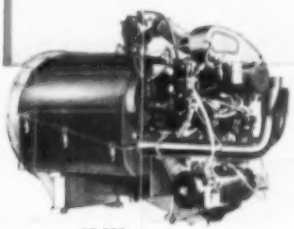
PC-60
4-cyl. 70 h.p.



PE-90
4-cyl. 110 hp.



PE-150
6-cyl. 175 hp.



PE-200
8-cyl. 250 hp.

Air conditioners, crash trucks, compressors, generators, test stands, refuelers, heaters, blowers, Rollagons, multi-purpose trucks—it would be hard to name a type of ground support equipment which one or another of the five Continental Packettes isn't either doing, or equipped to do, better than any other engine. . . . . These Military Standard power plants (Mil. E-6449-A) are approved for use in equipment for all branches of the Armed Forces. Developed by Continental Motors, on whose aircraft engine models they are based, they span an output range from 30 to 250 horsepower. They combine light weight, compactness, and ease of servicing and upkeep with the rugged stamina for which Continental has been known for 56 years. . . . . Packettes are built to operate in any temperature from sizzling desert heat to 65 below zero, power output being automatically governed to the load. They feature unusually wide interchangeability of parts—among themselves and among models in Continental's aircraft engine line—and complete supplies of parts are maintained all over the world.

In short, IF THE APPLICATION FALLS WITHIN THEIR POWER RANGE, NO OTHER POWER PLANT WILL DO THE JOB SO WELL

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ATOMIC ENERGY

New Medical Research Center

The Nation's newest atomic medical research center, including the world's first nuclear reactor designed specifically for medical use, was dedicated in December at Brookhaven National Laboratory, Upton, N. Y. Brookhaven is operated by Associated Universities, Inc., for the U. S. Atomic Energy Commission.

In addition to the reactor, the new Brookhaven Medical Research Center includes a 48-bed hospital for research patients and laboratories for studies on medical applications of atomic energy.

Construction of the $6.5 million Medical Research Center was begun in mid-1956 as part of the Commission's program for research on the medical applications of atomic energy.

The Medical Research Reactor includes unique design features. Two ports on opposite sides of the reactor permit streams of neutrons from the core to pass through the heavy concrete shielding walls into treatment rooms, one for patients and one for experimental animals. The beams can be shut off by means of thick 21-ton shutters in three seconds. In addition the kinds of radiations in the beams can be varied by inserting various combinations of absorber and "converter" plates in the beam. This makes for unusual flexibility where reactors are concerned.

A third face of the reactor is equipped for the general irradiation of large objects and the fourth has tubes, called "rabbit holes," leading into the core to permit irradiation of small samples of various materials for diagnostic purposes and the making of short-lived radioisotopes. The availability of these isotopes at the hospital site, where they can be used quickly before they decay, will make possible a broad range of medical investigation into fundamental body processes.

These rooms and facilities are enclosed within outer concrete shielding walls and the whole is encased in a steel cylindrical tank.

The reactor will be served by physicist-reactor operators under direction of the staff physicians. The patient under treatment will be under direct visual control of the physician at all times. Other than the molded shapes of the ports in one wall, the treatment room for the patients is like that in any hospital.

Brookhaven has pioneered the experimental use of reactor-originated neutrons for treatment of some types of brain tumors. In this treatment, the patient is given an injection of boron, which has an unusual capacity to capture neutrons. From a reactor a beam of neutrons is directed at the brain tumor at a time when the boron is concentrated there. When the neutrons strike the boron nuclei, short-range radiations are produced, which can destroy tumorous tissue with minimal damage to surrounding healthy tissue. The treatment still is in the research stage, but results to date have been promising.

The Brookhaven medical scientists have been utilizing the laboratory's general research reactor for this work. The new medical research reactor is expected to deliver a treatment beam having a neutron intensity about fifty times as great as that provided by the general research reactor, reducing the exposure time and making possible wider medical applications of neutrons and greater flexibility of treatment.

The new reactor will have enriched uranium fuel elements, and will be cooled and moderated by ordinary water. It has a nominal operating power level of 1,000 kilowatts.

In addition to research on neutron-capture therapy, the Medical Research Center will be utilized for an extensive program

of investigations utilizing radioisotopes in the diagnosis and treatment of a variety of diseases. These problems range from laboratory studies on the molecular structure of biological chemicals and structures to the care and management of patients receiving specialized diagnostic tests and treatment.

The laboratories and the research hospital are housed in a one-floor building of approximately 110,000 square feet, plus a basement area of 22,000 square feet for mechanical services. The reactor is housed separately in a steel building 60 feet in diameter and 54 feet high.

The laboratory sector includes special facilities, such as cold rooms, constant-temperature rooms, humidity-controlled balance and instrumentation rooms, animal rooms, and areas for handling radioactive materials and for special equipment such as ultracentrifuges.

The 48-bed hospital is located in four identical circular nursing units with a central area for auxiliary services. A nursing station is located in the center of each of the four circular units.

Patients with diseases under study are accepted only by referral from the physician having charge of and responsibility for the patient. The patient is referred to the Medical Center's Hospital, where one of the physicians on the hospital staff assumes full charge of and responsibility for the patient.

U. S.-Euratom Joint Research

The United States Atomic Energy Commission and the Commission of the European Atomic Energy Community announced recently that they are prepared to receive proposals for research and development centered on nuclear power reactors to be built under the joint U. S.-Euratom program.

This research and development program is an integral part of the joint program contemplated by the Agreement for Cooperation between the U. S. and Euratom signed in Brussels on November 8, 1958. The over-all industrial objective is the installation within the next 5 to 7 years in the Euratom Community of U. S.-type power reactors having a total electrical generating capacity of approximately 1,000,000 kilowatts.

While the agreement will enter into force only upon completion of statutory requirements in the United States and Euratom, proposals are being solicited at this time in order to expedite the process of review and evaluation so that the research and development program can be initiated promptly upon the effective date of the agreement.

As stated in the Agreement for Cooperation: "This research and development program will be aimed primarily at the improvement of the performance of the reactors to be constructed under the joint program and at lowering fuel-cycle costs. It will also deal with plutonium recycling and other problems relevant to these reactors."

This research and development effort is to be carried out over a 10-year period and will be financed by equal contributions from the AEC and Euratom. For the first 5-year period the total funds available are expected to amount to about $100 million; funds for the second period may be in the same order of magnitude.

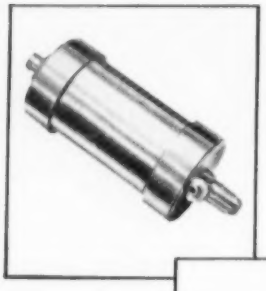
It is planned that roughly half the funds will be spent in the United States and half in Europe for research and development contracts and for experimentation on the reactors to be built under the U. S.-Euratom agreement.

Proposals may be submitted by any person, institution, corporation, or group in the United States or in the Euratom countries, or by groups with both U. S. and Euratom representation, including reactor manufacturers and constructors and suppliers of fuel elements. The association of European and American personnel in the projects is encouraged. *(Contd. p. 716)*

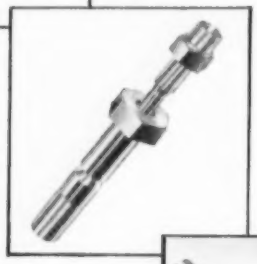
EXPLOSIVE ORDNANCE

Products And Explosive Systems Design And Development For

- **MISSILES**
- **AIRCRAFT**
- **ROCKETS**
- **GROUND SUPPORT**



GAS GENERATORS



EXPLOSIVE BOLTS

PRESSURE CARTRIDGES

McCormick Selph Associates is a leader in the development and manufacture of products and systems in the field of explosive ordnance. Use of explosive ordnance devices can effect high savings in weight and the maximum reliability necessary to successful operation of missile, aircraft and ground support systems under all environmental conditions.

Mc S A research engineers are now investigating new materials, methods and applications in the field and developing new products to meet an expanding need.

Company growth has opened a requirement for the addition of several explosive engineers at project engineer level. Applicants are invited to submit resumes to Mr. Frank La Haye, Vice President Engineering.

McCormick Selph Associates

HOLLISTER AIRPORT, HOLLISTER, CALIF.

Atomic Energy (Contd.)

Proposals may cover work in any field which the proposer considers relevant to the objectives of the joint program.

Financial support for acceptable proposals may take the form of complete or partial payment for the cost of research and development work performed.

To implement the research and development program, the AEC and Euratom have created a Joint Research and Development Board. Among the functions of the Joint Board are the receipt, evaluation, and selection of proposals, and over-all technical guidance of the work contracted for.

Proposals may be submitted at any time and will be evaluated upon receipt by the Joint Board in accordance with specified criteria. These include potential contribution of the proposed work to the program and the technical competence of the proposing organization. Among other factors to be considered will be the cost of the proposed work and the willingness of the proposer to participate in the exchange of technical personnel. All proposals must indicate willingness to comply with information, reporting, patent, and other requirements specified by the Board.

Underground Tests

The following statement on the detection and identification of underground nuclear tests has been prepared by the President's Science Advisory Committee and has received the concurrence of the Department of State, the Department of Defense, and the Atomic Energy Commission. It is based on conclusions reached by a panel of seismologists appointed on the recommendation of the Chairman of the President's Science Advisory Committee:

Since the Geneva Conference of Experts last summer, United States seismologists on behalf of the Government have continued to study all available data on the problem of detecting and identifying underground explosions, including new data obtained from the underground tests conducted in Nevada this past October. These studies and new data indicate that is it more difficult to identify underground explosions than previously had been believed.

The Geneva Conference of Experts last summer concluded that, although it is not possible to identify an underground explosion by seismic means alone, it is possible to identify a large fraction of seismic events as natural earthquakes when the direction of first motion of the seismic signal is observed at several appropriately located stations. This procedure reduces the number of seismic events which would be unidentified and could, therefore, be suspected of being underground tests.

Analysis of all available seismic data on underground tests, including the data new since last summer, has shown that this

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method of distinguishing earthquakes from explosions is less effective than had been estimated by the Geneva Conference of Experts. These analyses and new data also indicate that the seismic signals produced by explosions are smaller than had been anticipated and that there are consequently about twice as many natural earthquakes equivalent to an underground explosion of a given yield as had been estimated by the Geneva Conference of Experts.

These two factors mean that there will be a substantial increase in the number of earthquakes that cannot be distinguished from underground nuclear explosions by seismic means alone. For example, the total number of unidentified seismic events with energy equivalents larger than five kilotons may be increased ten times or more over the number previously estimated for the system recommended by the Geneva Conference of Experts.

The effect of this new analysis and data on the capabilities of the system recommended by the Geneva Conference of Experts as well as modifications of that system which could restore its originally estimated capability against underground tests are at present under study by United States scientists.

Grants for Equipment

The Atomic Energy Commission recently approved grants totaling $2,264,965 to forty-one universities and colleges for the purchase of laboratory equipment needed to expand their nuclear educational programs in the physical sciences and engineering. These grants are part of the Commission's program to assist in providing trained manpower for the atomic-energy field.

These awards marked the fifth in a series of grants under this program and bring to $10,929,674 the total that has been allotted to 106 United States educational institutions.

The forty-one grants include funds to seven engineering institutions for the purchase of teaching reactors. Institutions receiving funds for this purpose are University of Illinois, Kansas State College, University of Maryland, University of Texas, University of Washington, West Virginia University, and University of Wisconsin.

The seven reactor grants bring to thirty the total number of teaching reactors in operation, under construction, or to be constructed on campuses throughout the United States with the help of Commission grants. To be awarded funds for a teaching reactor a college must be accredited by the Engineers' Council for Professional Development and have a broad graduate nuclear curriculum. All schools receiving reactor grants are required to obtain licenses to construct and operate their reactors and to possess the nuclear reactor fuel.

The Commission's program is intended primarily to assist qualified engineering schools in establishing or expanding their nuclear educational programs at the graduate level. Some assistance is provided to qualified nonengineering colleges offering four years of undergraduate work, depending upon the availability of funds.

Radioisotope Program

The Atomic Energy Commission recently established a new program of assistance to colleges and universities for education and training in radioisotope principles and technology.

The purpose of the program, which is one phase of a Commission effort to foster widespread use of radioisotopes, is to increase the number of scientists, engineers, and technicians qualified to contribute to and support the growing industrial use of radioisotopes and nuclear radiation. The program provides for financial aid in obtaining equipment.

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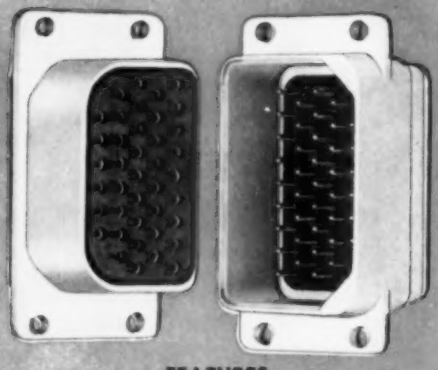

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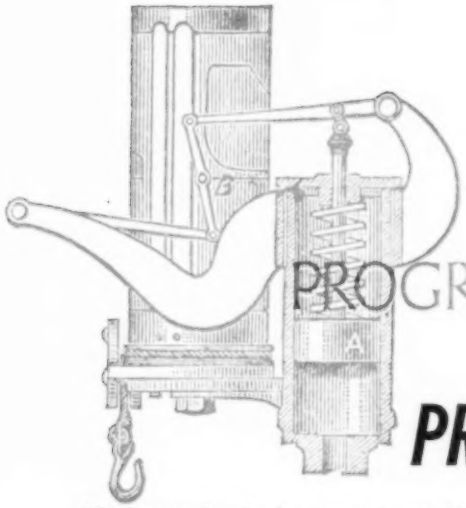

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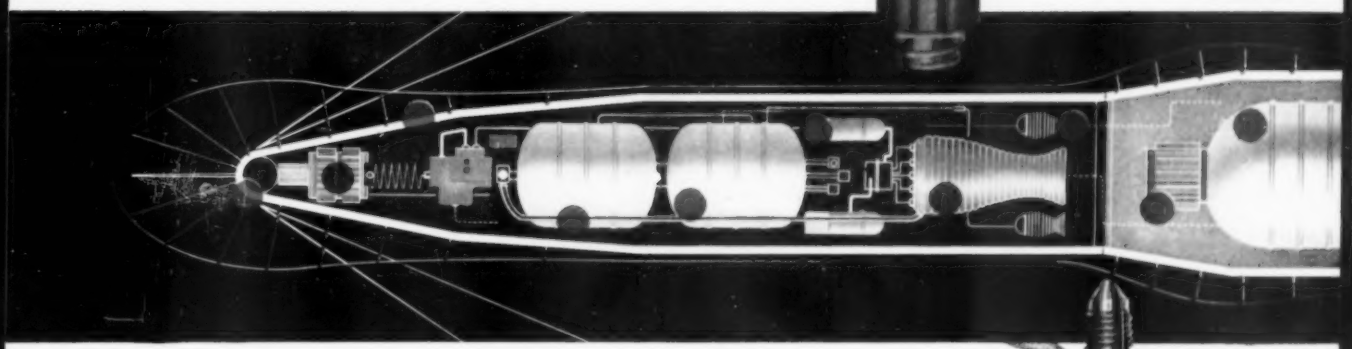

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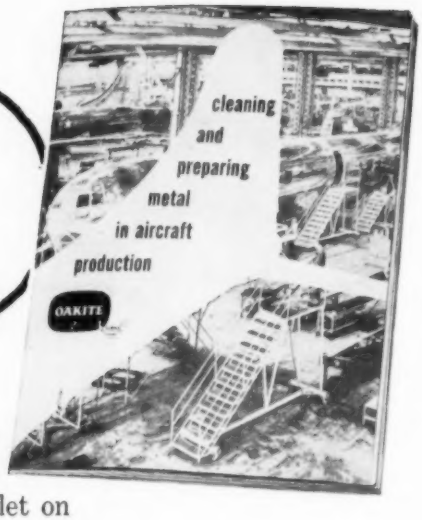

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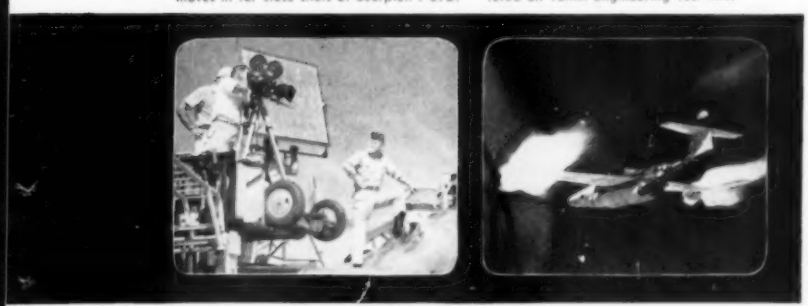

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LOUIS POLK

President, American Ordnance Association

Tradition of Leadership

New A.O.A. president has long service on the Industry-Ordnance Team

THE election of Louis Polk, distinguished industrial leader and strong proponent of armament preparedness, as the eighth president of the American Ordnance Association, was in accord with established A.O.A. tradition.

Lieut. Gen. Levin H. Campbell, Jr., set the standard near the end of his second year as president of the Association when he declined renomination and urged that, henceforth, A.O.A. presidents normally serve only two years.

A foresighted corollary to the general's recommendation was the proviso that the office be rotated among men in industry who had previous distinguished service in the armed forces, each service being represented in turn. He recommended further that, interspersed as appropriate, the office of president should be held by a leader in the industrial world.

Thus, the Association is ensured that in the full cycle of its operations, it will be truly representative of the Industry-Ordnance Team.

IN Mr. Polk the Association has a president who fulfills to perfection the criterion of outstanding industrialist through his years of dedicated work to improve the accuracy of American machine tools. His efforts have been instrumental in perfecting the precise and rugged equipment that makes possible our mass-production techniques.

Sheffield Corporation, a specialist among specialists, with Mr. Polk as president, has been one of the leaders in producing ultraprecision machine tools and industrial measuring devices. And, in World War II, Sheffield was among those machine-tool producers whose skill and sleepless nights and days of work enabled the United States to be the arsenal of democracy.

It is indicative of Mr. Polk's tireless energy and ability that when Sheffield Corporation merged with Bendix Aviation Corporation, he accepted the duties of a group executive vice president and director in the latter organization in addition to retaining the presidency of Sheffield.

Louis Frederick Polk, of Dayton, Ohio, eighth president of the American Ordnance Association, has had a long and distinguished career with Sheffield Corporation, now a subsidiary of Bendix Aviation Corporation. Elected president of Sheffield in 1941, he is also group executive vice-president and a director of Bendix.

A native of Dayton, Mr. Polk was graduated from Miami University, Oxford, Ohio, and was the recipient of an honorary doctor of science degree from that university in 1958.

As a leader in the field of metrology and scientific measuring instruments, he and his company recently established the Eli Whitney Metrology Laboratory to provide private industry with precise measurement facilities comparable to those of the world's leading government standards laboratories.

Mr. Polk represented the United States on pneumatic gaging at the International Conference on Engineering Dimensional Metrology, in London, England, in 1953.

He has served as a vice-president of the Ordnance Association in charge of its Technical Divisions and Sections since 1951. He also served as president of the Association's Cincinnati Post.

Among his honors are the Ordnance Gold Medal for Outstanding Service, the Navy Civilian Citation, the Secretary of War's Civilian Citation "for outstanding service in time of war," and the American Society of Tool Engineers' Engineering Citation.

Throughout his career of continuing and expanding responsibility our new president always has taken a keen interest in A.O.A. affairs. Both locally in the Cincinnati Post and nationally as a member of the Board of Directors and as vice-president in charge of Technical Divisions he has given generously of his time and his wise counsel on behalf of the Association.

Louis Polk's sincere interest in the Association is typical of the hundreds of industrial and scientific leaders who, with the thousands of engineers and technicians, comprise the majority of our membership. They are the backbone of the Nation's production force who must supply the fighting equipment—for our armed forces.

The welding together of the civilian and military components is one of the basic reasons for the existence of the A.O.A. wherein a common meeting ground is established to encourage mutual confidence between our defense forces and industry.

NO one should know better what is needed than the fighting man and the engineers with whom he is in daily contact; no one can produce it in needed quantity and superior fashion better than the industrial members of A.O.A. A splendid example of this mutual confidence encouraged by the Association is in the meetings of the Association's Technical Divisions and Sections.

Under the leadership of Louis Polk with his vast knowledge of all aspects of A.O.A. operations and his wide acquaintanceship throughout industry and the armed forces, the American Ordnance Association will continue in the forefront of preparedness.

Our Military Posture

Recent political and technological changes are threatening our Nation's existence, making it necessary to maintain adequate deterrent and retaliatory forces to prevent or win a nuclear war

Vice Adm. John H. Sides

IT seems almost inconceivable that in one generation we should have seen the art and science of naval gunnery advance from the rather rudimentary systems of the 1920's through the stages of sophisticated rangekeepers, remote control of guns, including huge 16-inch turret guns, stereo-rangefinders, and finally radars and proximity fuzes. By the end of World War II a straddle on a surface target on the first salvo was the rule rather than the exception, and an aircraft kill on the first burst from an antiaircraft battery was not totally unexpected.

But now, as we perceive the changing threat, we must realize that the importance of such systems is on the wane. It is with a mixture of sadness over their passing and of challenge for the future that we roll up our sleeves and get on with our jobs.

WITHIN the Navy throughout this era of ascendancy in gunnery, one name stood out during my active career —that of W. H. P. Blandy, known and affectionately referred to as "Spike" Blandy by those who had the privilege of working with him. Admiral Blandy passed away suddenly in 1954, and, on the occasion of his burial in Arlington Cemetery, I was given the sad duty of commanding the honor guard.

As I stood there in the snow on that cold, cloudy day, and as the mournful notes of "taps" sounded through the trees, accompanied by the sharp crack of the rifle volleys, I felt that I was witnessing the end of an era. Political events and technological advances since that time have given ample evidence that this was true.

Admiral Sides is Director, Weapons Systems Evaluation Group, Department of Defense, Washington, D. C.

On the political side we find that the U.S.S.R. has, through ruthless and utter disregard of all the principles of freedom and the dignity of humans, reached the point where they literally control or wield overriding influence over approximately one third of the world's population and one fourth of its real estate. And we find ourselves upholding the principles of freedom through various pacts, alliances, and federations which constitute much of the remainder of the earth.

We find that the Soviets, by misuse of the veto, have strangled every major constructive effort of the United Nations, and that they have, by overt and covert means, continuously interfered with the efforts of many smaller nations to maintain their sovereignties according to their own free choices.

On the technological side we find that advances in weaponry have done much to render obsolete many of the so-called conventional weapons of World War II. It would be worth while to take a brief look at some of these technological advances in order to understand more fully the impact which they have wrought, as well as the vastly increased capabilities which they have made possible and the costs which must be borne if we are to employ those capabilities or defend against them. Let me oversimplify the problem by looking at just three major developments which have tremendously influenced the character of the armed forces of the nations of the world.

FIRST, I believe we should consider the jet engine for aircraft. As long as we were shackled to propeller-type engines and aircraft we were limited to relatively slow speeds. We also were limited to moderate altitudes, so that antiaircraft artillery could be quite effective for ground-to-air combat.

Then along came the jet engine! Aircraft speeds, altitudes, and general combat performances skyrocketed. The usefulness of the aircraft gun and the unguided conventional rocket began to fade. Now, in air-to-air combat between two high-performance aircraft, those types of weapons are almost completely useless. This fact should not astound any one who takes the trouble to use a little grade-school arithmetic. Two Mach 2 planes flying toward each other head-on will approach each other at the rate of almost a mile every second.

With guns and unguided rockets, the old-fashioned tail chase could never culminate in actual combat. Only the

head-on approach would offer any chance at all. And here such an interception would require extremely precise vectoring of the attacking fighter from ground stations. The eyes of the pilot would be useful only in looking at his instrument panel. Even human reaction time, from the instant the pilot willed to fire to the instant he actually pressed the trigger, would defeat the system.

This brings us to the guided missile. By utilizing air-to-air guided missiles whose range we measure in miles, it becomes possible to attack from any angle and to fire anywhere within a huge envelope of air space surrounding the target. Reaction time is no longer important. Precise direction from the ground is no longer nearly so important. The missile possesses its own guidance system and has speed and maneuvering characteristics which completely outclass the plane being attacked.

THE foregoing discussion should give us a rough idea of why we simply must have air-to-air guided missiles if we are to carry out successful air-to-air combat in this day and age. An example of their effectiveness is seen in the outraged cries which came from Peking and Moscow when the Sidewinder missile brought down several MIG's off Formosa.

In much the same manner, the jet engine and the increased ceilings and speeds of aircraft which have resulted from its use have brought antiaircraft artillery to the brink of obsolescence. Modern airplanes can fly at altitudes where antiaircraft guns simply cannot threaten them. This fact has spurred the development of surface-to-air missiles which can reach altitudes beyond which planes can fly with speed and maneuverability exceeding that of manned aircraft.

There is one other very important reason why we need guided missiles of the types just discussed. This brings us to the third great technological breakthrough—the development of the atomic and thermonuclear bombs. In the days of the massive bombing raids during World War II, if the defender could levy an attrition rate in the neighborhood of ten per cent on the attacking bomber force, plans for continuing such attacks became unprofitable.

The advent of the nuclear, and later the thermonuclear, bomb has changed all this radically. The tremendous yields of these bombs and warheads as well as the damage which they are capable of inflicting mean that attrition philosophies of past days are no longer good enough. It means that we must have the capability to destroy attacking bombers with certainty and at great distances from their objective.

This is another reason why we must have air-to-air and surface-to-air missiles whose ranges vary from several miles to several hundred miles and which can deliver either high-explosive or nuclear warheads against attacking bombers.

NOW let us look briefly at our general war offensive forces. At the present time these forces are made up of the Strategic Air Command, which represents the major portion of the long-range striking force; the nuclear-capable Navy attack squadrons based on our mobile attack carriers, which make a significant contribution; and the fighter bombers of the Tactical Air Command. A large proportion of the Tactical Air Command's bombers are stationed overseas, but the remaining portion can reach trouble spots, even from the United States, in a relatively short time.

Before discussing these forces further, perhaps we should look at the philosophy of "deterrence." We sometimes fall into the habit of thinking of deterrence and retaliation as one and the same. Indeed, they are closely related, in a manner of speaking, but if deterrence is successful there will be no need for retaliation in the future.

Valuable new additions to the fleet are the guided missile cruisers CANBERRA, left, and BOSTON, right (Navy photo).

A deterrent force can be no more effective than a potential enemy believes it to be. It serves its purpose through the mechanism of convincing the enemy that it is strong enough, and effective enough, and invulnerable enough, and that should an enemy attempt to launch an attack upon us he would immediately be counterattacked with such effectiveness that, in the final analysis, the net result would be to his unacceptable disadvantage.

IN this light the air-defense forces of the United States also contribute to deterrence by causing doubt in the enemy's mind that his initial attack will be completely successful. It is conceivable, of course, that a weak or ineffective force might serve the purpose of deterrence if the other side were gullible enough to believe it to be strong. In our democracy, where annual budgets are a matter of public record, where the media of the press and radio discuss in detail our military posture and describe our bases and installations, where there is unrestricted travel so that anyone may see for himself, there is no possibility for creating deterrence by bluff or by hoax.

As long as we maintain a strong deterrent force, the likelihood of a thermonuclear outbreak will be small. Fortunately for us and for the world, we do have such a force. Mr. Khrushchev's frequent public utterances in which he threatens to "bury us," and stress the "obsolescence" of our SAC bomber force, are just so much hogwash. In this way he hopes to threaten and scare unthinking peoples and at the same time to reassure the home folks who may be restless.

The Strategic Air Command is a powerful, efficient, well-trained force, capable of accomplishing the task it was set up to do. Its readiness is maintained day and night, seven days a week. It poses no threat to the peace of the world, as Russian propaganda would have the world believe. On the contrary, it is a stabilizing force of great effectiveness.

In any discussion of guided missiles, we must consider surface-to-surface missiles—specifically intercontinental ballistic missiles. There is every indication that the major threat is changing in character. The launching of the Sputniks has eliminated all doubt that the Russians have the scientific know-how and the technological capability to develop and employ ICBM's carrying warheads of very high yield. We are doing likewise.

Against this type of weapon system all presently developed and deployed defensive systems are of no avail. The ballistic missile has certain unique characteristics which could make it extremely effective in the deterrent and the retaliatory roles. First, there is its potential quick reaction time. By this I mean the short interval between warning of attack or orders to fire and the instant when it can be on its way. As we further develop the solid-propellant types, this reaction time will become extremely small. Secondly, there is the very short transit time to target—a half hour from continent to continent. Thirdly, it is extremely invulnerable to enemy air defenses. Further, it has potential invulnerability on site. It is susceptible of being placed on hardened sites so that it can survive a heavy surprise attack and still be successfully launched. Add these characteristics and you have a very effective weapon system—one which some have had the temerity to call the "ultimate weapon."

But already we are developing antimissile systems which give promise of countering the threat in the air, and we are talking of accuracies so good that hardening of land-based sites may give only a passing invulnerability. And so we go on and on with the old battle of offense and defense.

We are now working on the ballistic missile early warning system, commonly called BMEWS. Such a system, with radar stations in the Far North, will give us perhaps fifteen or twenty minutes' warning that an attack upon us has been launched. Now we begin to see the logic of the SAC alert-force concept—a force which is becoming more effective day by day.

If a potential enemy were to be so desperate as to launch a ballistic missile attack against us before we have developed and deployed an antimissile system, those minutes of warning would be sufficient for a decisive force of bombers to leave their bases and be en route to their targets even before the arrival of the enemy warheads. The knowledge of this capability should be a powerful deterrent against such an attack.

ANOTHER effective weapon system is the fleet ballistic missile or Polaris which is launched from nuclear submarines. This system has several unique characteristics which should be of advantage to us and which should

"The American Ordnance Association in appreciation of outstanding service to the national defense of the United States awards its Maj. Gen. C. C. Williams Gold Medal to Vice Adm. John Harold Sides, Director, Weapons Systems Evaluation Group, Department of Defense.

"Throughout his distinguished career in command at sea, in naval ordnance activities, and in high government office, Admiral Sides has made outstanding contributions to the modern armament of this Nation. His accurate appraisal of weapon effectiveness and broad understanding in the application of scientific method to ordnance development have been a strong influence in the timely delivery of new weapons to our Army, Navy, Marine Corps, and Air Force.

"The wise counsel, steadfast guidance, and keen insight of Admiral Sides have helped to generate a tremendous array of modern arms which are progressively increasing the power and readiness of our armed forces.

"The American Ordnance Association confers upon Admiral Sides with full appreciation its gold medal named in honor of Maj. Gen. C. C. Williams, Chief of Army Ordnance, 1918-1930, and a founder of the Association."—Citation accompanying award of the Williams Gold Medal to Admiral Sides at the Fortieth Annual Industrial Preparedness Meeting of the American Ordnance Association, New York City, December 3, 1958.

give the gentlemen in the Kremlin a few ulcers. The submarines will be able to stay on station independent of outside logistic support for long periods. The recent exploits of the NAUTILUS and SKATE are an indication of what I mean. They will fire their missiles from beneath the sea and their mobility will render them invulnerable to enemy missiles.

The submarines on station will not present targets in our homeland for enemy missiles. They will force the enemy to mount a costly and extensive antisubmarine effort. And wherever those submarines may be, they will represent units of United States sovereign territory, free of all political encumbrances. In the light of these considerations, it becomes extremely difficult for me to envisage a strategic posture of the future which does not include a significant Polaris force.

WHEN I extol the attractive features of these various missile systems, I sincerely hope that I am not giving the impression that the day of the manned bomber is drawing to a close. It is necessary to understand that we have the bombers today and they are tremendously effective, whereas the missiles are still under development.

As enemy antiaircraft defenses become more effective, the task of the manned airplane will become more and more hazardous. As each year goes by we shall see our missile capability able to assume a greater portion of the load. But, as of today, our manned land-based and sea-based aircraft are what we must depend upon. For a long time to come, there will be certain specific tasks for which the bomber will offer the best solution.

To summarize, we find ourselves faced with a very serious threat and we need the means to counter that threat. In a manner of speaking we are really faced with a new way of life. The enemy possesses a large bomber force and an adequate stockpile of high-yield weapons. So do we. The enemy is developing an ICBM force capable of delivering high-yield warheads. So are we. The greatest deterrent to their use is the certain knowledge on both sides that each has the capability of grievously damaging the other.

There is another kind of threat, not specifically or directly connected with that of all-out thermonuclear war, and this is the threat of limited war. Perhaps it would be better to describe it as the threat of "wars of limited objectives."

A great many persons in this Nation seem prone to categorize our present uneasy status as peace, but this seems hardly the word to describe it. If one reads the works of the champions of Communism he cannot escape the fact that their ultimate objective is world domination. In the Communist quest toward this goal there is no such thing as a backward step. Rather there is unceasing pressure, sometimes less active, sometimes extremely belligerent, but always a pressing forward toward achievement of their aims. In their minds there seems no clear-cut dividing line between peace and war.

They certainly do not show any inclination toward overt fighting which might involve the organized combat forces of the U. S. and the U.S.S.R., but they do keep the pressure on, first here, then there, by propaganda, economic warfare, inciting and infiltrating the governments of lesser nations on the fringe areas, threatening, and even supplying so-called volunteer forces. They will do it just as fast and as far as possible without causing the United States to exceed its boiling point.

Make no mistake about it. This is war, not peace. And in such a situation there is always the danger of a miscalculation.

We need still another kind of effectiveness against this type of threat. We can have it and must have it in the form of forces which can cope quickly and effectively with localized situations which may develop. It must apply whatever force is required, not excluding tactical nuclear weapons.

IT could well be a result of the Soviets' continual probing, which stops just short of the boiling point, that these smaller conflagrations or potential conflagrations are the situations most likely to occur. Certainly the existence in sufficient strength of the type of forces we need for this purpose will have a great deterrent effect, and, should deterrence fail, they also will be able to put down, quickly and decisively, outbreaks which do occur and which otherwise could spread until they are out of control. It would seem to behoove us, then, that in our efforts to deter the all-out war we do not neglect the capability for actions of more limited scope.

The fact that Navy task forces operating in waters far from our homeland have historically exerted a stabilizing force in troubled areas hardly can be disputed. Their mere presence, coupled with their characteristic mobility, will, in many cases, do the trick. Beyond this, the airplanes of a carrier task force, specially trained and equipped to fur-

The FORRESTAL is an important part of the Navy's mobility (Navy photo).

nish effective close air support to ground troops, coupled with our seagoing fleet Marine forces, are able to exert the required force quickly and effectively.

Air support of such operation is assured in the early and important stages of a campaign, even though there may be no airfield within a thousand miles. This is the ready force which has been developed through more than a century of working, training, living, thinking, and fighting together as a team. It has demonstrated its readiness in the Mediterranean, in the Far East, and in other portions of the world.

ARMY Airborne and other troops stationed strategically also are available for similar types of duty. However, there is more dependence in this case on ready airlift and ready sealift. New Army weapon systems are under development, and in some cases are already available. If these were on hand in sufficient quantities, they could give the ground forces a measure of self-sufficiency unknown before the advent of missiles and nuclear warheads.

There also are units of the Tactical Air Force strategically located in various forward areas, ready on short notice to support ground operations.

In recent months there has been much discussion as to whether we are devoting a sufficient percentage of our available resources to ensure the effectiveness of our limited-war capabilities. It is argued that this type of force is the one which can exert great influence upon the day-to-day workings of international relations. It also can give us added strength, not only in the trouble areas of the world but at the conference table as well. The balance between the support to be given our all-out general war deterrent and retaliatory capability and that accorded our so-called limited-war capability is a problem which certainly deserves the continuing serious consideration of our policy makers.

The character of our task in the Weapons Systems Evaluation Group has changed quite markedly with the passage of time. Even the name is no longer precisely descriptive of our activity, unless one is willing to look upon a weapon system in its very broadest sense.

"Already we are developing antimissile systems which give promise of countering the threat in the air, and we are talking of accuracies so good that hardening of land-based sites may give only a passing invulnerability. And so we go on and on with the old battle of offense and defense."

By the changing character of our duties I mean that the great preponderance of our efforts is devoted to furnishing the Joint Chiefs of Staff or the Secretary of Defense timely analyses and information on which they can base decisions which may, in some cases, influence the course we are to pursue far into the future. How many strings to our bow must we have to do a job? Does the projected threat really require a new weapon system? What is the technological promise of achieving our goal? What will be the budgetary and personal requirement, and over what time scale? What is its relationship to other systems available in the same time period? Where should emphasis be increased or decreased? And so on.

Our roster includes about a hundred analysts and scientists who are recruited and administered by the Institute for Defense Analyses and thirty-odd military officers with special knowledge and backgrounds. When the military officers report for duty they are no longer working for the services from which they came. We make a determined effort to be as objective as humanly possible because we know there can be no place for service politics or party lines in our organization.

We also know that, if we are to do our job effectively, we shall win no popularity contests. We have access to

information of all kinds, wherever available, and we have good working relationships with the heads of the agencies concerned, with the White House staff, the Department of State, and others.

What the Department of Defense does is decided first at the highest levels of our Government. The President and the National Security Council, using information based upon a wide spectrum of information on all aspects of our national economy, our gross national product, the international situation, and the like, must chart the general course we are to follow. Our national policy having been set, the Secretary of State and the Secretary of Defense must ensure that our foreign policy and our military posture are complementary and that they support our national policy.

The Joint Chiefs of Staff and the service Secretaries must advise and be guided by the policies of the Secretary of Defense to ensure that, within the resources made available to the Department of Defense, we achieve a military posture which will best serve the national interest. In this cycle, I would be remiss if I failed to mention the all-important part played by Congress, which each year hears the case, makes such adjustments as it deems prudent, and then appropriates the funds.

In summary, it would appear that we are faced with a situation where political and technological changes during the last decade have placed us under a type of potential threat far exceeding in seriousness any which has beset us in the past. We see that it is necessary to maintain adequate deterrent, retaliatory, and defensive forces for preventing if possible, and winning if deterrence fails, an all-out thermonuclear war. We know that it is also mandatory to maintain adequate forces for preventing or bringing wars of limited objective to a quick, successful conclusion. We must recognize that the more serious the threat the more expensive will be the means to cope with it.

THE problems which face our Nation today are tremendous. Those which face the Department of Defense are staggering. The teamwork between the military and industry is more than ever required to give us the sophisticated weapons systems of the present and the future. We need, we expect, and we know that we can count on the American Ordnance Association to continue to give us the kind of support and assistance which this unique organization is so admirably organized and equipped to render.

Atomic Power for Defense

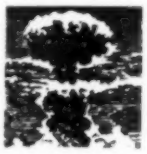
The Los Alamos Scientific Laboratory through its basic studies into the nature of the atom and its cooperation with the military services has done much to develop the new science for both war and peace

Dr. Norris E. Bradbury

IN 1945 the Los Alamos Laboratory was disorganized. There was a great debate raging as to whether the control of the atom should be in civilian or military hands. There was even a debate as to whether Los Alamos should go on at all. Perhaps it should become a ghost town, memorializing in some obscure way the horrors of war and of atomic bombs.

In spite of these problems, and, in spite of his lack of any real authority to take the responsibility in his own hands, General Groves made a decision that Los Alamos, indeed, would be a permanent place with a primary responsibility—that of looking to the effective military use of atomic energy, specifically, the further development of nuclear explosives.

The implementation of this decision seems curious and very simple, but it was of fundamental importance in the practical operation of a laboratory. General Groves decided to build some good houses—that was all, but you can hardly imagine the beneficial effect on the morale of people who were wondering: "Shall I stay here? Shall I go back to my university? Shall I go back to industry? Shall I remain and try to make Los Alamos an effective institution for the safety and progress of this country?"



The continued life of Los Alamos was almost a direct consequence of this one rather simple decision—to build some good houses.

Dr. Bradbury is Director of the Los Alamos Scientific Laboratory, Los Alamos, N. Mex.

It did not seem so simple at the time, and as I pursue the problem of keeping people happy and providing housing at Los Alamos, I wonder how he did it.

At Los Alamos we have also discovered that research for defense is a 2-way street. Some have said that research is the pursuit of useless knowledge, but actually research is the pursuit of knowledge, some of which you hope will be useful and some of which you are certain will be useful knowledge.

We pursue a great many areas of basic research, not because it is useless, but because we know that some fraction of it, and we have always underestimated the size of that fraction, will turn out to be useful knowledge. Such, indeed, was the research which led to the process which resulted in the development of atomic energy as a useful tool for man and for defense.

The discovery of fission was a process of pure research. Meitner and Hahn were looking at a typical laboratory phenomenon—what took place when uranium, an interesting heavy element, was bombarded with neutrons. Out of this experiment there seemed to come some curious particles. They studied these particles, and finally the United States and the rest of the world learned of their research. It was discovered that a process was taking place in which mass was being converted into energy—the process of fission.

Now this might have stopped right there—not for reasons of science, but for reasons of nature. Nature was rather curious in this respect. She made the fission process just barely able to work, just barely able to be useful. If there had been fewer neutrons per fission given off, it could have remained an academic curiosity, useful merely in understanding the structure of the nucleus. But nature did not do that; nature made the number of neutrons per fission just large enough to cause something like a chain reaction.

HAD there not been among the scientists of this country a general awareness of the needs of national defense, the process of fission might still, in spite of its potentialities, remain a laboratory curiosity. This is why research, and specifically, research for defense, is a 2-way street.

The scientists were aware that this was a process which might, if the suitable conditions could be found, lead to the release of enormous amounts of energy.

Scientists knew enough of the needs of their country and its defense to raise this question at the highest national levels. Could this new phenomenon in physics not be made of use in the course of the present war?

The nature of this proposal was sufficiently important and sufficiently supported that, indeed, the atomic weapon did become a reality.

But before that materialized, let me again describe this interplay between defense and research. As I have said, it was possible to make an atomic bomb, but we also knew that an atomic bomb which could not be delivered would be a totally useless and academic enterprise entirely wasteful of funds and effort. So the first thing that had to be done before an atomic bomb could be considered was for the scientists to approach the military and say, "Look, we have here a chance to make a new weapon, but it is only useful if it can be delivered."

The system is extraordinarily important and must provide the answers to such questions as: "What do you expect to have in the way of delivery systems in three or four years?" "What will they be able to carry as to size and weight so that we may direct our research, studies, and development in a way which will be useful to you as part of a system?"

The development proceeded with this continuous interplay of what could be done militarywise and what could be done technically. The basic point to reiterate again is this—the fact that there might be a useful military phenomenon in the process of atomic fission occurred first of all to the scientist.

IT was his obligation, as a scientist, to bring it to the attention of the military and to seek their advice and help in connection with the system. From then on it was a matter of constant interplay between the two to discover what could be done on the military side and what could be done on the scientific side.

The same thing has been true in the years which followed the first use of atomic weapons in 1945. We, at Los Alamos, had to be sufficiently aware of the needs of the military to direct our research properly. We did not have to be professional strategists or tacticians, but then as now we had to be sufficiently aware of the trend of military systems, military needs, and the area of military requirements so that our research could go along lines which had the greatest probability of providing some measure of satisfaction for those needs.

At the same time we had a continuing responsibility to inform the military of the most recent trends of research and development so that they, on their part, might develop systems to meet the requirements we set through continued research and development.

One of the areas in which this interplay sometimes breaks down is that of desired military requirements or characteristics. Sometimes a little knowledge is a dangerous thing, and sometimes it is a very annoying thing.

Once the military became aware that atomic bombs existed, that their characteristics and their use, size, and weight, were subject to variations as requirements for services dictated, we began to receive specific requirements.

I cannot give you the desirable characteristics of an atomic bomb because of security restrictions, but I will paraphrase the way the specifications sometimes read. If they were written for an airplane, they would sound like this:

"We want an airplane with the following characteristics: It must fly at speed of about Mach 10. It must weigh 5,000 pounds. It must land at 20 miles an hour. It must be fairly safe so that if all power supply fails it will land without injury to crew or device. It must have a maximum efficiency, must be easy to maintain, and must not cost more than so many dollars per pound."

An airplane designer would laugh at this. He would say: "What are these people talking about? Don't they know the facts of life? Don't they know that nature does not seem to permit some of these things?"

We find the same problem in atomic weapons. There has to be continuing interplay to accomplish what can be done. We, on our side, need to be spurred by the military: What do you need? What do you really need? What can you possibly use?

They, on their side, need to be spurred by us: We see development going on in this direction. We see potentialities here. Can you make use of them? Can you put your ingenuity and the ingenuity of military laboratories and military people to work on the question? How, given a device like this, would you make it useful? In other words, how would you build a system around it?

Military needs have equal responsibility in research. What can be had? The scientist cannot operate in a vacuum. He has to operate in close contact with his military friends.

They, in turn, must operate in close contact with him. This has been the objective of Los Alamos over these years—to find out what direction military requirements are taking and, in research, to tell the military in what direction scientific developments are going. This has led, in the case of atomic weapons, to a wide family of developments.

THE first step after the war was to pursue a number of lines of attack. I do not know whether to call them research or not. I do not know what research is. I can point out its wide extremes, but I think the debate as to what is basic and what is not is academic. We now have a number of lines of attack to follow. The chosen line of attack had to be one which had the least possibility of providing insurmountable obstacles, coupled with the greatest certainty of its being accomplished. This did not mean it was the best approach, but we pursued it to its ultimate conclusions.

We had this task to carry out—pointing it in these directions. We had long been aware that basic research was being done early in the 1940's on the other source of energy for military use; namely, the fusion process as opposed to the fission process. The thing was called then "the superbomb," but was renamed "the hydrogen bomb" and now the "thermonuclear bomb."

We knew that energy was there. We did not know how to make use of it, but we refused to be stymied by something which did not disobey the first or second laws of thermodynamics. I think that will always be the case. Until something fails to obey those laws or is in violation of them, the scientists

will say, "I wonder how I can make it work?"

This was the case with the hydrogen bomb. We were aware that this would provide the military with another factor of increase, roughly on the same scale as the effective increase of the atomic bomb over chemical explosives. Considering the factor of 1,000, you increase from tons to kilotons in the first place and from kilotons to megatons in the second place.

To solve the accompanying problems we tried every possible avenue of attack. Our solutions did not look possible—in fact they looked pretty impossible, but it did seem as if we would provide a military system. However, it looked as though it would require a battleship to deliver it, which was not promising. Even in the successful initial test of a technique, it was far from a military system.

But we saw a way through this problem, and now the spectrum has been extended over wide areas. Whether or not there exists another factor of 1,000 in atomic weapons, I am far from sure. Whether or not such a factor would be useful, I am even less sure. That there remain many problems in atomic weapons with which we and our colleagues at the University of California at Livermore have to deal, I am positive.

Most of these problems will, again, have their interplay between the scientist in his laboratory and the military man in his particular area of competence. How can what we do fit into what you need? How can what we are thinking of be applied by you, in ways you have not thought of yet?

I WOULD like to discuss one other problem in which we are interested which again comes out of the research laboratory and has to be considered in somewhat different context with the Department of Defense and other interested agencies. This is the problem of the use of nuclear energy for the propulsion of rockets.

Los Alamos does other things than just work on atomic weapons. The second nuclear reactor was built at Los Alamos. We have by now built reactors there as tools in nuclear physics and to explore the production of power.

Air Force

One of the areas we decided to exploit as we began to broaden the base of our operations in the early part of this decade was this production of power. One of the ways in which we proposed to do this was to look at the specific, and at that time almost a military question: Can nuclear rocket propulsion play a role in driving very large, very heavy, payloads for very long distances? We had a background for this —a background provided by a scientific research and development program directed almost entirely toward the development of high-temperature materials.

We discussed the possibilities with the Department of Defense shortly after the existence of a very-large-yield hydrogen weapon had made an intercontinental missile a reasonable military system.

At that time, chemical rocket motors were not in their present advanced stage of development, and there was even some doubt as to whether or not they would be capable of driving an Atlas-like missile. We proposed, then, another string to this bow—a more difficult and longer-range string.

This proposal was accepted, and the laboratory proceeded to undertake a program of research and development looking toward the feasibility of nuclear rocket propulsion. This is an unanswered question. The feasibility may or may not exist. It is our task to find out and describe what may seem to be feasible to the military or to the space agencies and discover if this particular technique has a practical application. As a country we must know the answer to this.

It is obvious at the present time that the missions of nuclear propulsion are going to be the very heavy and long-range payload and not the small systems, just as it is now obvious that chemical motors can provide the necessary thrust for the typical Atlaslike missile.

This is an area of research and development growing out of a program of fundamental research which is characteristic of a laboratory like Los Alamos.

In general, I think this is true of any laboratory of this sort. There is a wide background of basic, fundamental, exploratory research which has to be very, very forward looking. We must get five or six times ten years ahead of what it is we will need to know ten years hence.

We were doing research in cross sections of deuterium for the thermonuclear process back in 1943, although we did not know what to do with them or how to use them until the early part of this decade.

THIS is the broad background of basic research which culminates in specific developments whose character, nature, and utility are determined by intimate contact between the users in military organizations and the developers in the other organizations. Without this 2-way flow of information, one side is deprived of the most important part of technology and the other side is deprived of the opportunity to provide its maximum enhancement of our national defense.

The Armed Threat

In addition to closing the gaps in our weaponry that give the Communists an edge in combat power, we also should close the constitutional gaps that slow our reaction to surprise attack

Maj. George Fielding Eliot

PRESIDENT Eisenhower opened his State of the Union Message for 1959 with a question of supreme importance:

"Can government based upon liberty and the God-given rights of man permanently endure when ceaselessly challenged by a dictatorship hostile to our mode of life, and controlling an economic and military strength of great and growing power?"

Later in the message, he added:

"The threat we face is not sporadic or dated; it is continuous. Hence we must not be swayed in our calculations either by groundless fear or by complacency. We must avoid extremes, for vacillation between extremes is inefficient, costly, and destructive of morale."

On the day following the reading of the President's message, the Select Committee on Astronautics and Space Exploration of the House of Representatives issued a report which warned against "crash programs" and went on to say:

"To start and stop programs is the most expensive and dangerous way to undertake them . . . Budget pressures in the short run should not be the primary basis for decisions on space programs which are inherently long range and which involve the very survival of the Nation."

Most of this is nothing new. Much of it has been said before. What is new, on the political front, at least, is the outright recognition of the continuity of the Communist threat. Heretofore there usually has been interwoven into policy statements and public utterances a weakening fiber of flimsy nonsense which added up to wishful thinking that maybe the bad man would go away and let us alone, or, to be more precise, maybe the Communists would agree to disarmament with ironclad safeguards—which, of course, means Communist abandonment of the objective of world domination—an unlikely prospect indeed.

Acceptance of the concept of continuous threat as a basis for American policy is, therefore, a notable step toward realism. Realism in the military aspects of policy requires, as the editors of ORDNANCE pointed out in the November-December 1958 issue, the realization "that there is a safe level in all departments below which we must not go." This "safe level" has to be established in relation to national military objectives which, of course, means also in relation to enemy capabilities.

The President's message sums up our objectives briefly: "We seek to prevent war at any place and in any dimension." If local disputes flare into hostilities, our "problem would be to keep the conflict from spreading." These two objectives are familiar to us under the labels of deterrence and containment.

Deterrence is concerned with a level of retaliatory power which keeps the Soviets constantly aware that resort to all-out nuclear war on their part would *inevitably* be followed by their own destruction by nuclear retaliation.

CONTAINMENT is concerned with a level of flexible power which can be applied in due measure wherever necessary to prevent piecemeal Communist expansion at the expense of the free world, in so far as force is appropriate to this purpose.

That the maintenance of these force levels, now and for the future, will demand understanding and cooperation between the President and Congress, hardly needs emphasizing. The cry for better machinery of Executive-Legislative cooperation is an old story, too, especially when—as at present—one party holds forth at the White House and the other party is in control of the Congress.

Major Eliot is military analyst for the Mutual Broadcasting Company and naval correspondent with General Features Syndicate.

With the exception of this article, all the other regular and technical articles appearing in this issue are based on addresses and seminar papers delivered at the Fortieth Annual Industrial Preparedness Meeting of the American Ordnance Association held in New York City, December 3, 1958.

Bipartisanship in military policy has been more or less taken for granted, to the extent at least that the national survival has been an acknowledged objective of all political leadership, regardless of party. But to meet and counter a continuing threat we need something more substantial than patched-up temporary experiments or comfortable assumptions. In the presence of a continuing danger, the power of constitutional government must be capably and efficiently exercised.

Rearrangements in this sphere are not reached overnight. They have to be worked out by the processes of give and take over a period, sometimes, of years. These processes are difficult and politically dangerous; prudent men shy away from them unless under the spur of urgent necessity. Urgent necessity, however, is right here with us.

We are facing a 2-year period in which the problem of national security is acute and imperative. There are indications of disagreement between the President and Congress as to what should be done. In particular, there is a strong tendency among the Democratic majority in both houses to criticize the Administration for giving too great emphasis to budget-balancing at the expense of military requirements.

IN the last session of Congress, funds were appropriated to maintain the Army, Marine Corps, and National Guard at higher manpower levels than the Administration desired and to lay down four more Polaris-firing submarines than had been requested in the budget.

The National Guard legislation was couched in terms that the Attorney General considered mandatory; the four extra submarines have been accepted by the Administration; the reduction of the Army and Marine Corps is, it appears, to proceed unless the current Congress finds means of preventing it.

These, however, are but straws in the wind.

The dangers that the country will face during the next two years are very great. In large part, though not altogether, our safety during those years will depend on what already has been done, on weapons we have in hand or on order now, and on men we already have at least started to train. But if we fail during those two years to make wise and prudent provision for the years immediately ahead, by the end of 1960 we can be approaching the point of no return.

The President says "We must weigh, judge, and select. . . . Needless duplication of weapons and forces must be avoided." True. But there has been too much weighing, judging, and selecting by those primarily concerned with cutting expenses rather than establishing a sound and *continuous* level of defense. There also has been too much rushing into programs sparked by Sputnik-panic, in the apparent desire to present a picture of missile activity to the public and to our allies with very little regard to the actual usefulness of the weapons thus procured to the military security of a nation which is pledged not to strike first or by surprise.

The example of the intermediate-range missiles, Thor and Jupiter, is pertinent. Here the problem has long been presented, in a climate of passionate controversy, as to a choice between these two missiles. Now it is beginning to appear that the liquid-fueled, fixed-base ballistic missile of intermediate range has no value whatever in terms of any vital American military need. It can reach Communist targets only from bases located in the territory of our overseas allies. The Communists are very far ahead of us indeed in the production and readiness for action of this type of missile. Therefore the locations of our proposed Thor and Jupiter bases are already zeroed-in by the enemy.

As one well-informed commentator said regarding the single Thor base we have been able to establish overseas, "These missiles would be radioactive dust before they could be fired."

Our allies are not enthusiastic about seeing these weapons emplaced in their bosoms—they seem to regard them as threats rather than added protection. Secretary of Defense McElroy, returning from a visit to allied capitals, indicated an intent to discontinue the production of these weapons on the ground that unexpected "break-throughs" in the development of intercontinental missiles, to be based in the U. S., made the Thor and Jupiter of "marginal" value.

YET the House Space Committee's report, mentioned above, quotes an authoritative source to the effect that a thoroughgoing American effort to catch up with the Communists in space programs (which include, of course, intercontinental missiles) cannot "close the gap" in much less than five years. Therefore the ICBM bases in the United States will be "under the gun" too, as the Soviets press their advantage in developing these missiles.

The issue of ORDNANCE which carries the editorial that inspired this article also carried some other very interesting items. One told of the development of the Snark intercontinental "cruise" missile, pointing out its small cross section, which makes it difficult for early-warning radar to detect, and its ability to attack either at high or low level and to "saturate" hostile air defense if used in cooperation with bomber aircraft, avoiding unacceptable manpower losses.

If this is true of Snark, at ranges of say 5,000 miles, what shall be said of the "saturation" possibilities of the Navy's Regulus II, which can be fired from surface ships or submarines (mobile bases, not subject to surprise destruction) at 1,200- to 1,500-mile ranges and at 2 to 3 times the speed of Snark as well as many times the rate of fire? The conclusion is obvious. Yet in this year's budget, Regulus II has been "weighed, judged, and selected"—out.

This is just one example of the throwing overboard of a tested weapon—probably the most efficient air-breathing missile in the world—because, as the official statement put it, "other missiles have a greater development potential." This presumably refers to Polaris—which we won't have before 1960, and not in significant numbers for a year or two years after that, if it, too, doesn't give way to "short-term budget pressures" in the meantime.

It is upon subjects of this crucial nature that the new Congress seems likely to ask very pertinent and persistent

questions indeed. What is the exact level of our deterrent power *now?* What will it be a year from now? How much of it is subject to surprise destruction if the enemy decides to exercise his privilege of shooting first? How much of what is left over will be able to penetrate the enemy's rapidly improving air-defense system? Is the amount of nuclear firepower we could actually deliver against Communist targets after sustaining a surprise attack diminishing? Is this margin of delivery capability, which is the true measure of our deterrent power, sufficient to restrain the Soviets from taking bolder and bolder risks?

And what is the nature of the risks we will run in future, if it becomes necessary again to go "to the brink of war"? Will these risks increasingly involve the arrival of Soviet H-bombs in our own homeland, or those of our allies? If so, will our own boldness and firmness be adversely affected?

Or, considering limited situations, how many of the four divisions of our Strategic Army Corps are actually at full strength and ready "around the clock"? If we had to send just one full-strength division to the Middle East or Southeast Asia from the United States, how long would it take us to get it there with a due measure of logistic support behind it? Why did the Chief of Naval Operations, speaking at the commissioning of the new aircraft carrier INDEPENDENCE, find it necessary to warn her crew that every man would have to be capable of extra effort because the ship would not be fully manned? How long will it be before the Regular Army will be fully equipped with the new rifles and machine guns of which the first production orders have been issued this year? How long before the National Guard will have these weapons?

IS it not true that when the Nation faces a continuous threat from a powerful and determined enemy, *time* is the controlling factor—and that means an appreciation of time in terms of relative armament and readiness at any given moment? Can we allow the enemy to enjoy even one day of overwhelming superiority without risking our national survival if he makes use of his opportunity while he has it?

Congress is going to be asking these and many more questions, and wisdom suggests not merely that the Administration be ready with the answers but that there should be much closer and more continuous consultation between the pertinent committees of Congress and the Department of Defense, as to the details of the defense program.

Congress is acquiring definite views on national strategy which should command the respectful attention of the

Executive. No one who has read the excellent reports lately produced by Congressional committees or by the Legislative Reference Service of the Library of Congress can have any doubt that, increasingly, Congress is formulating military concepts for which it will demand due attention. The report of the House Space Committee is one example. Another is found in the report of the Senate Armed Services Committee on Military Construction Authorization for the fiscal year 1959, from which the following is an illuminating excerpt:

"Too great a defensive psychology can result in a 'Maginot Line' concept. Defensive operations in the opinion of the Committee should not be hampered by the absence of initiative which the Committee believes is inherent in fixed positions. . . . In the Committee's opinion, a 100 per cent defensive psychology is a will-o'-the-wisp which has led nations committed to it to defeat or bankruptcy or general war. We must certainly provide adequate defense for our striking or retaliatory forces, but we must establish our true defense on mobility, dispersal, striking power, and diplomatic and military policies designed to prevent war."

Nothing but confusion in the public mind and disaster to the national security could result from a head-on, politically motivated clash between Congress and the President on these vital questions of military policy.

We must realize that the Democratic leadership in Congress is determined that their party, should it come into possession of the White House in 1961, shall not inherit disaster. We must realize that the Republicans will be determined to defend their record and will not readily admit, directly or indirectly, responsibility for shortcomings in our existing military programs.

This writer is not concerned with the allocation of praise or blame for these shortcomings. Yet they exist, and they must be corrected if the Nation is to oppose the continuing threat of Communist power policies with continuing counterforce of adequate capabilities.

The separation of powers between our legislative and executive branches is and has long been a major complication to the development of sound military policy on a continuing basis. This writer is far from being a constitutional scholar, and ventures to propose no long-term solution of this difficulty. But as the Soviet missile program, designed for the surprise disarmament of the United States, rises toward peak strength, the necessity for close and earnest cooperation between the President and Congress during the next two crucial years becomes manifest.

COOPERATION is a two-way street —much will be determined by how far the men upon whom fruitful cooperation will depend can lay aside personal and partisan considerations that the Nation may live.

What can be accomplished during the next two years will, of course, be in the nature of an emergency expedient, like keeping SAC aircraft in a state of constant alert. The SAC alerts are said to be necessary in order to help "close the missile gap." We also need to close weapons gaps that give the Communists an edge in armed power. But we also should close the constitutional gap that slows our political reaction time as we face the continuous threat of a powerful foe who can take his decisions in secret and execute them without warning.

A continuous threat can be dealt with only by continuous readiness—and the political mechanisms of a more leisurely age need overhauling in the age of space-flying missiles. In this process the experience of the next two years may well be a lamp to guide our steps through future perils.

Systematic Research

If sufficient basic study is done we can reduce substantially the cost of subsequent development and production necessary to secure adequate military strength for the United States

Dr. Allen V. Astin

ANY appraisal of our technological strength or military potential always leads to a conclusion that more basic research is needed or was needed some time ago. Unfortunately, the nature of research is such that if we put it off until it is needed, it is too late.

Therefore, in any long-range planning, we must attempt to evaluate the needs of tomorrow in order to plan the research for today.

Research has another most important bearing in the present framework of things; namely, in terms of the cost of defense. We are confronted with very serious problems today in trying to keep our defense strength consistent with the ability of our economy to finance it. Here we find, on any systematic and proper appraisal, that if sufficient basic research is done, we can reduce substantially the cost of subsequent development and production necessary to secure adequate military strength.

INEVITABLY, the cost of any military program is much greater in the development or production stages than in the research stages. If sufficient research has not been done, then we have to resort to costly trial-and-error processes, or find out through empirical techniques which is the best approach. Whereas, if we had sufficient basic information between alternative approaches, based on research, we could make logical choices in advance.

Dr. Astin is Director of the National Bureau of Standards, Washington, D. C. These remarks were made by Dr. Astin as chairman of the morning seminar at the Association's Fortieth Annual Industrial Preparedness Meeting in New York City on December 3, 1958. The theme of the seminars: "Research for Defense."

I am most pleased with the opportunity of hearing representatives of the Army, Navy, and Air Force discuss their needs for fundamental research. Fortunately, I had the opportunity of participating in some of these appraisals in a number of instances, but primarily through contact of the National Bureau of Standards with some of their programs.

For example, during the past two years, we have played a sort of central role in an important fundamental research program of the Army. This is leading to information which possibly may have some important impact on higher energy fuels of the future. It is a study of the properties of those chemically active fragments of matter known as "free radicals."

We have been running a substantial program in this area where we have had representatives from industry working with our scientists. It has been financed by the Army.

For the Navy, we fortunately have been able to participate, through the Office of Naval Research, in a number of fundamental investigations. I think one of the most interesting and important is the Navy's support of our low temperature physics program.

Largely through Navy support of these activities of the National Bureau of Standards, we were in a position about two years ago to provide the experimental verification of one of the most important present-day advances in physics; namely, the overthrow of the rule of parity for weak nuclear interactions.

For the Air Force, one of the most significant activities has been in the field of radio propagation. Here we made some fundamental determinations of the properties of radio signals under various special conditions and provided, in a very striking manner, the illustration of the point I tried to make earlier—that if you have sufficient basic information in advance you can make decisions which obviate parallel approaches in development.

Writing in the May June 1956 issue of ORDNANCE, Dr. Astin stated: "The National Bureau of Standards' responsibilities require that we limit our services to industry by undertaking activities which can best be performed by or are unique to the Bureau. Thus we look to highly competent laboratories . . . to give to industry many services that it needs."—EDITOR.

New Shape in the Sky

The TM-76A Martin Mace, the Air Force's surface-to-surface tactical missile, shown above just after launch, can deliver a nuclear warhead at near-sonic speeds over a range of 650 miles. The Mace, an air-breathing missile with booster assist, will replace the Matador in the 587th Tactical Missile Group at Sembach Air Base, Germany, early this spring. This missile is one of a number of modern weapons with which the countries of the free world are being armed to deter aggression.

The Army and Research

The newest developments in firepower, mobility, communications, medical science, training, food, and protective clothing can be made available to our ground forces through science and industry

Maj. Gen. August Schomburg

RATHER than discuss whether or not the Army needs a program of fundamental research, I will tell you *how much* we need it and at the same time indicate the nonmilitary contributions our Army research has made.

The best way for me to prove how much the Army needs its research program is to indicate its magnitude, the great effort which goes into it and the importance we give it in our organization. Finally, to prove my point I will cover several advances which can be attributed directly to the Army's continuing research effort.

I will tell you the Why, What, Where, and How, and give you examples of what we have done, what we are doing, and what we hope to do in research.

All Army research effort is pointed at improving such areas as firepower, mobility, communications, and human resources, including such items as medical science, training, food, and protective clothing.

OUR research covers all of the primary sciences, and some of the specialized sciences.

The Army does its research in its own laboratories and by contract in universities and private industry. There are over 300 facilities involving more than 2,000 research projects.

Our Army's research effort is supervised by the Director of Research and Development, Dr. William H. Martin, and by Lieut. Gen. Arthur G. Trudeau as Chief of Research and Development. General Trudeau has an Army research office in Washington which coordinates the research efforts of the Army. Each technical service generally limits its research efforts to those which apply to its own missions, but at all levels our research is guided, not regimented.

General Schomburg is Deputy Chief of Ordnance, U. S. Army, Washington, D. C.

We were enthusiastic when the American Ordnance Association approved the establishment of its new Research Division. We are looking forward to the assistance this Division can give our Army research effort, particularly, that of the Ordnance Corps.

The preparation of firing and bombing tables always has been a time-consuming and laborious task, and an early research project was directed toward finding an easier way to do this job. The pay-off was the Eniac—the electronic numerical integrator and computer. Work on the Eniac started in 1943, both within the Ordnance Corps and under contract at the University of Pennsylvania. The result was the first electronic digital computer.

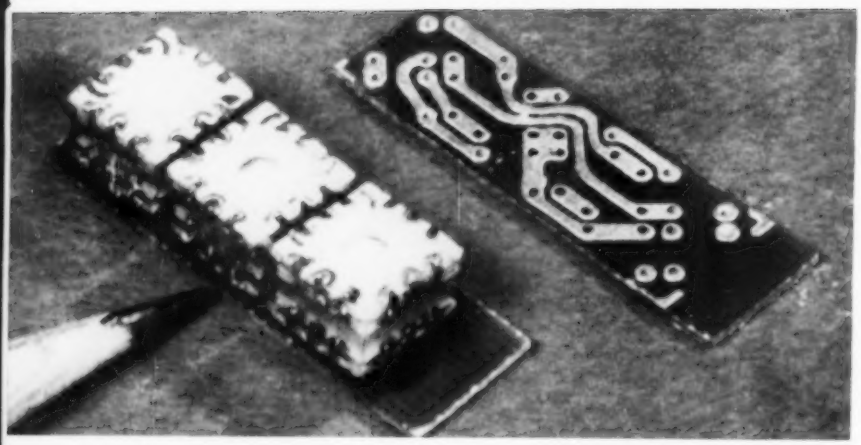
As installed at the Ballistic Research Laboratories at Aberdeen Proving Ground it contained over 18,000 electron tubes. Someday at least part of this granddaddy of all digital computers will be in the Smithsonian Institution.

This device established the feasibility of our current digital electronic computers and as a result spawned a computer industry in the United States which is estimated to exceed $350 million annually.

Great progress has been made since the Eniac. Modern computers, as a result of developments by private industry, are now smaller, faster, and have greater capacity. The Army no longer makes its own.

OUR pioneer effort at developing a binary counter filled a large room. Now we have gone to the other end of the scale to satisfy the demands of our missile systems and have microminiaturized the binary counter stage of a computer. This stage, packaged in one cubic inch, is equivalent to twenty-four vacuum tubes and seventy-seven additional components. Not only has the size been reduced by a factor of approximately 100, but the cost is being reduced by a factor of 10, and the computer is more rugged.

Future computer developments may be based on the superconductivity of some materials at very low temperatures. For example, if a small metal ring is immersed in liquid helium its temperature will be brought down toward absolute zero. If a current is established



Micromodule subassembly is only slightly larger than pencil point (Army photo).

in the ring at the time it is cooled it will continue to flow as a result of the superconductivity established by the low temperature. This phenomenon will make possible computers with huge memory systems and really high-speed operation. Our research is helping.

The solar furnace of the Quartermaster Corps is a unique device. One of its uses will be in the development of protective clothing. The furnace measures some 125 by 40 feet overall. It produces a 5-inch spot which has an average temperature of approximately 5,000 degrees Fahrenheit.

A heliostat follows the sun and collects its rays and focuses them on a concentrator. These two surfaces are made up of over 500 individual mirrors. The concentrator in turn focuses the sun's rays in a 5-inch circle in the test chamber. In between is a Venetian-blind arrangement which is used to start and stop the operation.

The furnace produces about 3,500 times as much heat as normal sunlight, and the big point is that this heat is free of contamination.

If any company has experiments it would like to have conducted in the furnace, this can be arranged by contacting the Quartermaster Corps' Natick Laboratories in Massachusetts.

At Aberdeen Proving Ground we have a blast sphere with walls about three inches thick that will withstand an explosive charge of 100 pounds. As time has gone by this research tool has been modernized, and it now is used to stimulate the vacuum conditions of the upper atmosphere. It is 30 feet in diameter and can simulate altitudes of 150,000 feet and soon will be capable of simulating altitudes to 300,000 feet.

The sphere is equipped with blast-recording and temperature-measuring equipment and missile-firing devices so that missile warhead components can be fired in the sphere. It is a useful tool in our upper-atmosphere missile and warhead work.

The Signal Corps has developed an extremely small waferized micromodule which contains the equivalent of approximately twenty electronic components. A handful of these modules could replace all the components in a television set, except the picture tube and the speaker.

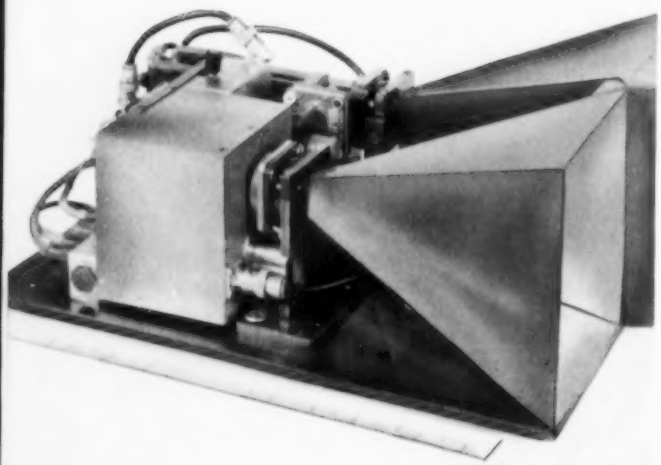
The Army's work on masers is yielding exceptional results. These new oscillators provide exceptional stability in frequency. If a maser could replace the escapement in your watch, the watch would gain or lose only 1 second in 300 years. These are important to the Army in obtaining accuracy in our missile systems, and since the answer usually comes out in range, they will prove useful in nonmilitary survey developments and astronomy.

Another development in the electronics area is a miniature high-resolution, short-pulse radar. It is unique because of its short pulse, and consequently this radar has no blind range. It has a range gate which will allow it to discriminate within one foot. The electronic equipment can be placed in a shoe box.

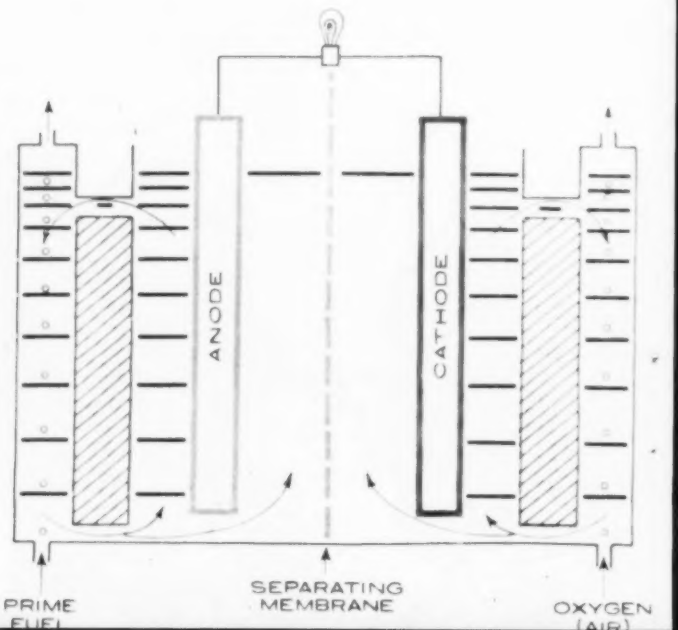
This type of discrimination holds great promise for guided-missile fuzing and also will contribute to range finders.

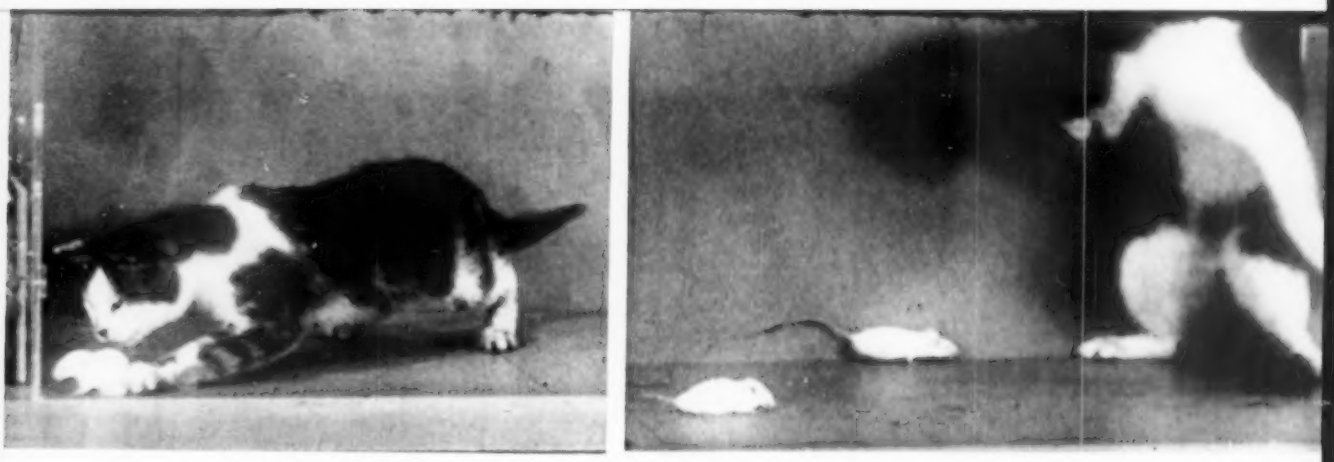
Everybody is interested in improving the fighting capability of the foot sol-

Miniature short-pulse radar set is just one foot long.



Schematic drawing of chemical fuel cell now under test.





At left, cat reacts normally to moose. Right, after dose of aerosol, cat leaps in terror from rodents.

dier. My next topic, wound ballistics, is an example of what the Army is doing in this field. This effort is aimed at improving the wounding capability of shoulder-fired weapons. A high-speed film taken at 15,000 frames a second in our wound-ballistics program shows three bullets fired into gelatin blocks which have the consistency of human flesh.

In the first instance the gelatin block is hit by a conventional bullet, and it makes a nice, clean, small hole. A legal-type bullet, developed later, causes much more damage. Finally, the cavity caused by a still later development of a legal-type nonexplosive bullet is such that any bones touched by it would be broken. I think you will agree that war is getting dangerous!

The Army also is helping to put flesh back together again. The Army Medical Corps has two outstanding examples of treatments which have resulted from its research, each of which will benefit not only the military but the civilian community as well.

The first example has led to a burn treatment procedure which now is used throughout the Army and the civilian community as well. It is called the "open-treatment method." In the past, burns have been treated by the application of one thing or another to the burned area. Medical Corps research has indicated that the best treatment is to do nothing to the burn—take good care of the patient but leave the burned area alone.

A picture of a soldier twenty-four hours after he had experienced a gas explosion shows his face covered with a second-degree burn, which is quite similar to that which he might have gotten from a nuclear explosion.

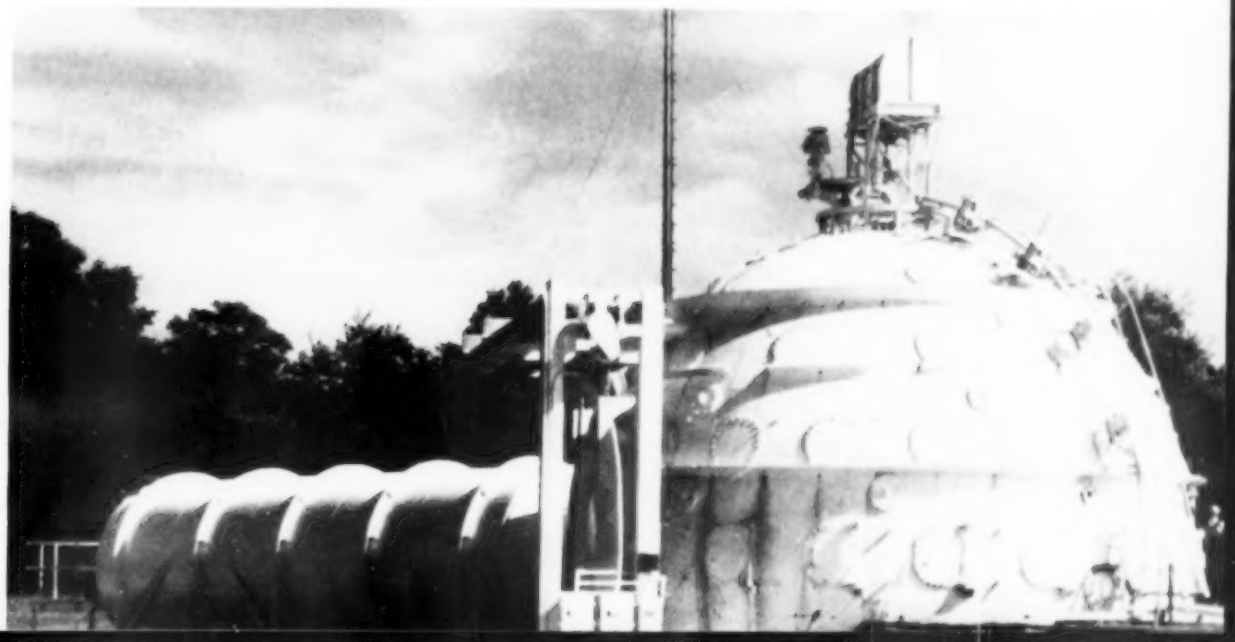
Thirty days after he was given the "open treatment" this man was returned to duty for useful work and was unscarred. This treatment is useful for third-degree burns as well.

Incidentally, for the first-degree burns of the type you might get around the house, the Medical Corps recommends the use of a little shaving soap of the kind you get out of one of the new pressure cans. It doesn't help the healing, but it does keep away the air and make the spot feel better, and, of course, it can be washed away easily the next day.

Another example of Army medical research is a program that has led to a procedure for repairing damaged nerves. Nerve injuries have been difficult to treat and often have resulted in the loss of use of arms and legs. The ends of severed or damaged nerves can be sewed together, but scar tissue invades the repaired nerve and prevents successful recovery.

This problem is being solved by the Army Medical Corps by the use of a

Blast sphere at Aberdeen Proving Ground used to test explosives under upper-atmosphere conditions.



material called Millipore. This paper-like substance is made of alpha-cellulose and has been developed under a Medical Corps contract. The Millipore is wrapped around the damaged area and allows the fluid that will feed the nerves to get to the nerve but restricts the entrance of cells that cause scar tissue. A sleeve of Millipore, then, is the secret to the solution of the problem of nerve repair.

A microscopic view of the nerve after treatment shows continuous black threadlike lines that indicate completely successful healing and the reestablishment of alignment as good as the individual wires in a telephone cable.

The original experiments were done with animals, but these nerve repairs are now being performed on humans. Not only can damaged nerves be repaired to prevent the loss of use of arms and legs, but there is considerable hope that even instances of long-standing nerve damage can be repaired.

Rust removal is not a very glamorous topic, but much has been done in this field through research. For example, such items as old rusty cartridge clips can be immersed in a cold solution, and, after electrolysis takes place, the rust drops to the bottom of the tank, leaving only clean metal.

Only the rust is removed, the process is fast, the temperature is low, and the new surface does not rust as quickly as the old. It will be a real money saver to the Army.

RESEARCH also is doing some interesting things to the Army's food. Food, of course, constitutes a big logistics problem, which is aggravated by the requirement that it must be preserved.

This requires bulk and weight for refrigeration. It's true that cans are light, but who wants to eat potted meat all the time?

Food can be preserved either by the use of heat, as in canning, or by freezing and refrigeration. Each of these methods kills or suspends the activity of the bacteria which make food spoil. A new method which promises considerable success is irradiation.

The Quartermaster's food irradiation program began in 1953 and really gained impetus in 1955. The best way so far found to irradiate food is by a cobalt-60 source. This method of processing may change the taste, the smell, and the color, but the resulting food is not toxic, and it is not radioactive.

Some of the vitamins and amino acids also may be affected, and as a result there have been extensive feeding programs to animals and to volunteer troops. A test team has eaten irradiated food and nothing else for thirty days with no ill effects—although six joined the Navy later! All results to date have been completely satisfactory and a 3,000-pound-per-hour capacity plant is now being planned.

Our biggest current problem in the Army comes under the title, "combat surveillance." Simply put, this means: Where are the targets we would like to hit? In the past, most of our firepower has been conducted on a line-of-sight basis. Optical instruments were adequate, and later radar enabled us to see through fog, clouds, and darkness. Now, however, targets are more illusive, faster, many are over the horizon, and first-round hit capability often is required.

This problem is far from solved. The present approach is to utilize flying drones which will, by one means or another, locate targets and either communicate or bring back the required target-location information.

Our research efforts in infrared detection, acoustics, radar, seismics, optics, and photography are all pointed toward the solution of this difficult problem. A related problem is the digestion of this combat information in time to use it after we get it.

ANOTHER problem for the future is presented by a requirement for better power sources. One idea, although not new, shows possibilities. This is a cell which will convert chemical energy directly into electric energy.

We are working with a contractor on such a device called a redox (reduction oxidation reaction) fuel cell. This cell is not too unlike the storage battery in your car, except that in this instance a fuel such as kerosene, Diesel oil, or gasoline is broken down by catalytic action to provide hydrogen. This takes place at the anode. At the cathode, oxygen from the air feeds the reaction, resulting in water and electrons.

The advantages of the fuel cell are that it is quiet, there is no smoke, and its operating efficiency could be high. We would hope that the efficiency of the cell would be something like 50 per cent as compared with the 12 to 15 per cent efficiency of the automobile gas engine.

Army research is aimed at achieving small size and weight so that the resultant cell could be used for vehicle propulsion or as a portable generator, and the pay-off will be big in reducing the Army's job of fuel supply. Under our present research program we hope to produce a workable 1,000-watt unit. We are still a long way from achieving our ultimate goal, but it is something well worth striving for.

IT would be nice to be able to fight at least part of a war without killing or wounding anyone and without property damage. This might be achieved by the use of an aerosol which would be breathed by enemy troops and temporarily diminish their will to fight and resist, or possibly just make them sleepy but have no permanent effects.

A recent experiment with a cat and a mouse showed some interesting possibilities in this direction. A normal cat and mouse were placed together in a cage. As was expected, the cat stalked the mouse, toyed with it, and finally gobbled it up. Then the cat was given a dose of an aerosol which completely changed its feeling toward the mouse. Instead of attacking the little rodent, the cat backed away in terror whenever it approached and jumped a foot in the air trying to escape the smaller animal.

Obviously, such a procedure possesses great wartime possibilities. However, we are still a long way from achieving the desired result, and Army research will continue to work toward the solution of this and many other interesting problems so that our national defense will be strengthened.

Basic Naval Research

The only way to maintain the effectiveness of our naval power and meet the increasingly serious threat of the Communists is to conduct a vigorous and comprehensive program of fundamental research

Rear Adm. John T. Hayward

FUNDAMENTAL research, or just research, was not bandied about in 1773 when the U. S. Navy was established, so there was no argument as to whether "fundamental" was applied or supporting. But in the first law passed by the Congress of the United States, the Navy was given the right to experiment with ships and guns.

Today, I am convinced that there is a continuing need for fundamental, basic research, just as long as it is a requirement for fleets to control the seas and project our power across them.

As we all know, research is not easy. I have my definition for it which a lot of people do not like, but it has wide application: "Fundamental research is the pursuit of useless knowledge, because if it were useful people would be working on it."

The only way we can maintain a modern fleet and the effectiveness of naval power is to conduct a vigorous and comprehensive program of naval research. The Navy has a long history and a lot of it centers in New York.

LITTLE is known now of Stephen Decatur except his wartime exploits in Tripoli. However, he was also the first man to devise means to bring up marine shells and specimens from the deep parts of the ocean and the first man to give a contract for a steam-propelled warship. In those days, too, a ship cost a lot of money. It amounted to $320,000 then but that was as nothing compared with the Polaris submarine or our aircraft carriers.

Admiral Hayward is Assistant Chief of Naval Operations for Research and Development, Washington, D. C.

The primary objective in research is to seek new knowledge and answer the question "Why?" Suppose man suddenly decided not to ask this question, "Why?" A lot of people argue that he would be better off today if the questions of yesterday had not been answered and if science had not provided man with the means for elimination of all life on earth.

In spite of today's tension filled world and the basic insecurities, I do not share this view. A new order of strength is required to cope adequately with the problems of the modern world today as in the past. Man either will progress or perish.

But the path of the researcher is a hard one, and he does not always accomplish what he wants.

In the conversion of the Navy to steam from sail, the path was not smooth, but you will always find people such as Joshua Wood, who was our first Chief Engineer and who built a 15 foot steam and sail cruiser. The Board of Admirals turned this ship down for the following three reasons:

First, of course, when you were sailing, the propeller created drag. This was very bad. Secondly, it had reduction gears, making it difficult to step the mainmast correctly according to the old sailing men. Thirdly, the smokestack put cinders on the quarterdeck, and the captain did not like it.

We have many distinguished examples of Naval research throughout the 1800's. For instance, Matthew Perry obviously did not agree with my definition of research, because in 1833 he started a naval lyceum for the diffusion of useful knowledge. In those days, most military men were explorers and, then as now, were interested in research and in improving the efficiencies and methods of doing their particular job.

THE Naval Observatory, for instance, was founded in 1830. It has done outstanding work in astronomy and in the tracking and space business, as we all know.

You will probably ask, "What has this to do with the fundamental research requirements of the Navy?" In World War II there was a great acceleration in the development of weapons and techniques. We were using facts, actual physical principles that had been discovered previously, and we were using up, as we say in the Navy, our seed corn.

There is no such thing as a "crash program" in fundamental research. Most such programs are based upon the already-known laws of physics.

When the Office of Scientific Research and Development went out of business at the end of the war, we in the Navy felt so strongly about fundamental research that we organized the Office of Research and Inventions, now the Office of Naval Research.

ONR, from 1945 until the formation of the Atomic Energy Commission and the National Science Foundations, led the field in the fundamental research area. Today we have 1,500 contracts with nonprofit organizations, universities, and some industry in fundamental research areas. These cover all manner of things from solid-state physics to fluid mechanics.

The Office of Naval Research, which has a very fine reputation in this business, has done some outstanding work. Take, for instance, the solid propellants in use today. The original Palomar work was done in 1946 and 1947 and came from research that was sponsored by this organization. We also feel very strongly about the fact that in the research business we must have well-educated scientists throughout the U. S.

We must never forget the challenge that faces us. Mr. Khrushchev has told us time and time again that he is going to beat us at our own game. He is not going to resort to general war; he is going to beat us economically and technically.

DURING the years from 1946 to 1954, thirty-nine per cent of all the doctorates granted in our country were sponsored or paid in part by the Office of Naval Research. This thirty-nine per cent of our Ph.D.'s in physical science is part of our contribution to the "seed corn."

As the world tempo is speeded up in basic research, war itself has become more complex. I go back to Mr. Khrushchev again. He makes combat more complex when he covers the whole spectrum of warfare. War to him is neither black nor white; it covers the whole front of economics, the political, the psychological, and the military forces in "peace" as well as "war." He has made it quite clear to us that we have to face this threat across a very broad front. This means that we have to be able to control and use the seas, and we have to be able to help our allies.

The problems that face us in these research areas are many and varied. It is of great interest to me, for instance, that the Russian oceanographic program is about thirty times the size of ours. They are learning the physics of the sea—and there is much to learn in this area that we do not know. In the fundamental research field, for instance, we would like very much to really understand the physics of sound under water.

One of our biggest problems in this regard is the submarine. We have made great progress, but we must never forget there is a lot of work to be done. We have a nuclear submarine, and the submarine now is no longer lame. However, it is still blind.

In order to utilize the nuclear submarine fully, we must first solve a key research problem so that the submarine can communicate reliably with surface ships and aircraft. Then we will have a 3-dimensional combat team.

In covering this particular phase, we have to remember always that we are working with the physics of the sea. If we could break the sound barrier, as I call it, which is the speed of sound in water of 4,800 feet a second under normal temperature, and really go to the speed of electromagnetic communications, we would be in business. It would be a terrific accomplishment. The mere fact of a submarine hidden in the invisible shield of the ocean gives it a tremendous potential, quite different from the submarines of World War II.

I want to emphasize that difference. In World War II, you knew that the job of the enemy submarine was to sink you. Today I wish that we could count on him coming only to sink us. Now he comes to invade and destroy and he cares very little whether or not he sinks us. He can damage our heartland to such an extent that the sinking of a few ships will mean little to him. Our big problem in the Navy is to meet this threat.

This threat is on the all-out side of the spectrum of war and constitutes a terrific weapon against us. It seems to make little sense for us to guard the northern regions and to build radar screens there, when a submarine fifty miles from New York can lay it waste very easily.

We do not see an easy solution to this particular problem. It is a very difficult one, and we feel that it is going to take a lot of hard work and a lot of exploratory fundamental research concerning the environment the submarine lives in. If we could strip the cloak of invisibility from the submarine it would no longer enjoy its relatively invulnerable position.

I HAVE not discussed the question of duplication in research. I call it "parallel investigation." I have tried to get the press to do this, but with little success. It is said, you know, that the Supreme Court deliberates and Congress debates, but that we in the services always bicker. I do not understand the semantics, but that is the way it is, unfortunately for us.

In the research business, competition is a tremendous factor. However, you will find that most good scientists do not want to repeat the work of another scientist unless they really question his results or need further information. Take the Army's burn treatment. Yes, we duplicated it, but we did it in an entirely different way.

I do not know the details, but it involves the use of the skin from an embryonic calf which is placed over the burn, thus eliminating scars. Such work is not duplication. To my mind this is fine research and opens another path to the accomplishment of something the other services need as much as we do.

Some of our other needs always seem to be plagued with problems of this nature. Physics, of course, is the same on the land as on the sea. Some people get excited when we ask for 750 feet of landing space on a carrier. But nobody gets excited when we add 10,000 feet of concrete to a runway. This seems odd to me when a foot is the same at sea as it is on land!

This creates a difficult problem, especially with modern aircraft. The Russians give their friends modern aircraft such as the Mig. 17, and 19, and

our World War II aircraft cannot compete with them. So the jet age made it very apparent to us that we had to extend our carrier landing space to 750 feet which I consider quite moderate. Every time I land aboard in a jet airplane I wonder how we are able to get down in 750 feet!

But this raises a question in the research area: Suppose we could get a vertical take-off aircraft, or a short-take-off aircraft, that could carry the load comparably and have the performance of our present planes. This would change the entire complexion of naval aviation. It also would help the Marines, the Army, and the Air Force. The key problem here is one of lift—the weight-to-thrust ratio of our engines.

We come now to the problem that we face in the United States of being wed to the systems concept. I have had to answer many questions by congressional committees and by Assistant Secretaries as to what airplane that engine is going in or what we are going to use this for. I usually reply and say, "It is the state of the art."

This is one thing that we have neglected in our country—consideration of the state of the art. We come up with a real full-blown system and present it. We have a real good show. We commit billions to it, and then we try to invent on schedule. Unfortunately, this cannot be done.

I could name program after program where this has occurred. If the homework in the state of the art had been done and the components had been available, we would have been able to put together a sensible system, cheaper, quicker, and more effectively.

IN the Navy research and development budget, forty per cent is devoted to systems leading to finished items such as the Polaris missile. Sixty per cent goes into the type of work that we know as basic, applied, supporting, and state-of-the-art work. This concerns the man who can make a better gyro. If anyone has a better way of producing it, and at less cost, we are for it. This is the sort of work that we like to do in state-of-the-art work.

Actually, results cannot be guaranteed in any of these programs, but there is no profit-and-loss statement. We in the Navy really have looked at this, because I am always asked such questions as "Why is the grass green?"

We have received from the General Electric Company an excellent study which shows from their profit-and-loss statement what research has done for the company. In the field of solid-state physics alone, you can see that they have made millions on the development of an idea.

In the military, it is difficult to show profit-and-loss statements. We feel, of course, that by showing more efficiency and being able to accomplish more with less men or with less dollars we have accomplished the researcher's objective.

Some of our biggest developments have come out of competition, which is good. The Sidewinder air-to-air missile came out of the exploratory work at Inyokern. The Chief of the Navy Bureau of Ordnance was in large degree responsible for this and was very farseeing when many people did not want the project carried out. He gave the Naval Ordnance Laboratory ten per cent of its budget in what we call exploratory work. This means the Laboratory could do anything it wanted, even if it wanted to see whether or not the grass was green—but its projects should have military application.

Development of the Sidewinder, whose history is well known, was stopped, or would have been stopped three or four times because the Air Force already had the Falcon missile. However, the project was continued and the Sidewinder has become a very fine weapon in our arsenal. This, to my way of thinking, is one of the best examples of the relative worth of fundamental research.

Do not confuse quantity with quality. We want good research, and I must assure you that, in the use of these exploratory funds in the laboratories, a scientist who comes in with a project has to compete with the other scientists in order to get his money and to get his job started.

I am convinced that all the services have a basic requirement for fundamental research or exploratory work to improve their positions, to be more effective, and to do the job that must be done in meeting the challenges the Russians are throwing at us. This is across the board, I say. This is all the way from total war down to the micro-war.

We must be ready for general war, but if we concentrate on one field and in one way alone, we are going to be licked. I keep coming back to Mr. Khrushchev because I just talked with Eric Johnson, who spent a weekend with him at Pitsunda on the Black Sea. Mr. K. made no bones about it—he was going to beat us economically and technically.

To my way of thinking, and I have said it in Congress, we do not have enough money in research and development. Maybe the Army does; maybe the Air Force does, but Naval Research does not. If we ever have enough money, Admiral Burke probably will fire me!

I BELIEVE that centralization of research—the attempt to make an optimum approach before you have done anything—is wrong. We will never accomplish anything worth while in the research business that way.

"The primary objective in research is to seek new knowledge and answer the question 'Why?' Suppose man suddenly decided not to ask this question, 'Why?' A lot of people argue that he would be better off today if the questions of yesterday had not been answered and if science had not provided man with the means for elimination of all life on earth.

"In spite of today's tension-filled world and the basic insecurities, I do not share this view. A new order of strength is required to cope adequately with the problems of the modern world today as in the past. Man either will progress or perish.

"But the path of the researcher is a hard one, and he does not always accomplish what he wants."

New Weapons Technology

In this period of exponential growth of power in military might the offense tends to dominate the defense, and our technology and science must keep our armed forces abreast of the new developments

Maj. Gen. L. I. Davis, U.S.A.F.

THE events of the past year have made the public keenly aware of the dependence of military strength on science and technology. To establish the fact that technology shapes our military strength and, more importantly, that its force is becoming greater and more immediate, I will draw on examples from World War I and World War II.

Any study of tactics and strategy and the composition of military forces will show varying degrees of reliance on offensive and defensive forces. Technological advances, rather than doctrine, have determined the dominance of one or the other.

World War I saw the end of cavalry—the symbol of movement and offensive in the nineteenth century. It also saw the introduction of two new weapons, the tank and the airplane, which so strengthened the offensive in the war which was to follow, World War II.

The French Army discounted the development of new weapons between World War I and World War II. They were overly impressed by defensive weapons, by barbed wire, trenches, and the massed firepower of artillery.

As a result, they used the great share of their defense budget to build the Maginot Line. This defensive line of fortification—pillboxes, tank traps, and underground barracks—extended from Belgium to Switzerland. When put to the test by offensive weapons in World War II, it failed. Obvious tactics with weapons well known to the French before 1940—tanks and dive bombers—by-passed the mighty defensive line and proved again the inherent advantage of the offensive.

General Davis is Deputy Commander for Research and Development, Headquarters, Air Research and Development Command, Washington, D.C.

But World War II witnessed tactical successes by the defense as well as by the offense. The turning of the Maginot Line was followed by the Battle of Britain, a defensive success made possible by a technological advance—radar. On the Eastern Front, the invasion of Russia by Hitler, ending in the siege of Stalingrad, was a score for the defensive.

The power of the offensive was not to be denied, however, and strategic air power, striking directly at the heart of Germany and Japan, determined the final outcome.

As in World War I, the closing months of World War II saw the introduction of new weapons with greater offensive potential—jet aircraft, V-1 and V-2 missiles, and finally the knockout punch—the A-bomb. Certainly that weapon proved conclusively the power of science to shape our military strength.

Why do I review these well-known facts? It is because I believe there are trends to be noted and lessons to be learned in the swings between defense and offense.

The first, of course, is the force of technology in determining the direction of the swing. No one will deny the strength of this force. The second trend is that toward the supremacy of the offensive. Even radar, which saved Britain from Hitler's bombers, strengthened the offensive by becoming the all-weather eye of U. S. and British bombers.

ELECTRONIC countermeasures, like radar, another passive tool of modern military technology, were probably more useful to the offensive bombing force in World War II. In any future war, they threaten to make a "Maginot Line" of any defensive weapon system based on radar information alone. Whatever the role of electronic countermeasures, whether enhancing the offensive or defensively blunting its effectiveness, the initiative always lies with the offensive.

The rapidly growing power of the offensive can be emphasized by noting how meaningless industrial mobilization has become, and how dependent we are on the force in being at the start of hostilities.

In World War I, industrial capacity was untouched by direct offensive action. In World War II, both sides had time to mobilize their industry to ca-

pacity. However, in World War II, offensive forces were brought directly to bear on industry as well as on military forces.

In the early stages of the strategic bombing campaign, Germany had the capacity to rebuild or substitute as fast as bombs could destroy. It wasn't until the final months of the war and the use of thousands of bombers that the capability to destroy exceeded the capacity to rebuild.

It is this comparison of the rate of destruction with the rate of production (or rate of mobilization) that emphasizes the new power of the offensive. Since one bomber, or one missile, can deliver in minutes as much destruction as all the TNT delivered on Germany during World War II, the capacity for *rate* of destruction has increased by many orders of magnitude.

WHEREAS in World War II we saw the rate of destruction barely overcome the rate of rebuilding, now the disparity in rates is a thousand to one. In the dynamics of a war between essentially offensive forces, it is not the total capacity for destruction but the *speed of application* of that power that determines the winner.

Technology has not only changed our weapons but has also changed the nature of war itself. In addition, military forces no longer oppose military forces alone. The breadth and indiscriminate character of their power is a direct threat to all from the very outset of hostilities.

The American public is aware of these trends and is alarmed and concerned about our national security. The press is devoting more and more space to our progress in weapons development, and our apparent lag in science and technology. This is good in the interest of an informed public opinion, but, carried to extremes, it has obvious disadvantages. Crucial facts often carry the highest security classification. Incomplete or selective presentations sometimes support erroneous conclusions—conclusions that would not stand up (and the public would not support) if all the facts and conditions were laid on the table.

We, in the Defense Department, have the structure and the authority to evaluate and choose between competing weapon systems. The Executive Branch of the Government has available the advice of the top scientific talent in the country and, through the Joint Chiefs of Staff, the top military judgment of our Nation.

One of the delicate decisions to be made is the balance between offensive and defensive forces. This decision can be made only after careful consideration of many matters in various security classifications. The anti-missile missile is an example of the problem facing the Defense Department.

While technically possible, the cost to place a thin shell of point-defense missiles over the many places to be defended in the U. S. is astronomical. And one must always face the prospect that the end result would be another Maginot Line—outmoded by science as it reshapes our weapons and our military strategy.

What then is the course to be followed in the future?

Inasmuch as science is reshaping our weapons, the strength of our military forces depends directly upon technology. If we wish to prevent the catastrophe of World War III, we must look to science and technology for the advances that will make us so strong that no nation will initiate the conflict.

Or, to put it another way, political posture is largely determined by military strength. Since it is obvious that science is determining our military strength, we must look to science and technology for the advances that will maintain our world leadership.

One aspect of science and technology and its effect on military weapons is the dynamic nature of its progress. For example: Aircraft speeds in 1910 were only 100 miles an hour. By 1920, this had increased to 200 m.p.h.; by 1930 to 300 m.p.h; by 1940 to 600 m.p.h; and by 1950 to 1,200 m.p.h. The X-1 flew at 1,650 miles an hour in 1953; the X-2 now flies at 2,150. Speeds have almost doubled every 10 years. It is safe to predict that manned aircraft will travel over 2,400 miles an hour by 1960."

Everywhere we turn we see examples of this accelerating growth in the United States. Industrial use of electrical energy has increased from 35 trillion kilowatt hours in 1920 to 60 in 1930, 100 in 1940, and 170 in 1950. The population of the country has grown from 123 million in 1930 to 132 million in 1940, and is now above 160 million.

The value of manufactured goods was placed at $35 billion in 1930, dropped slightly to $30 billion in 1940, then shot up to $90 billion in 1950 and is still going up. The number of college graduates increased from 120,000 in 1930 to 180,000 in 1940, and 425,000 in 1950!

Gross national product value has grown from $120 billion in 1930 to $180 billion in 1940 and $260 billion in 1950. Economists predict well over $400 billion will be reached by 1960.

We naturally ask, "When is this growth going to slow down?" Some say, "It cannot keep up. Natural laws and limits will place ceilings on further progress."

LET us look at a couple of examples: The speed of sound once was thought to be a physical boundary to the top speed of aircraft. A little over ten years ago, before the Air Force became a separate service, funds were refused for work on supersonic aircraft, and the idea of traveling faster than a caliber .45 bullet was derided. Today, ten years later, we have a strategic bomber than can fly at Mach 2.

Look at the population growth of the world. A popular concept of the last century was the Malthusian theory. It stated that the globe could support only a limited total population and would be stabilized at this level by famine, wars, and pestilence. But medicine, the industrial revolution, and modern agriculture destroyed that ceiling.

"I believe there are trends to be noted and lessons to be learned in the swings between defense and offense. . . .Whatever the role of electronic countermeasures, whether enhancing the offensive or defensively blunting its effectiveness, the initiative always lies with the offensive."

It seems hard for us to accept these accelerating growths as natural patterns. We tend to look at the future in terms of the levels of the past or perhaps to concede an amount of growth in the next decade equal to the growth in the past decade. A greater growth—a geometric instead of an arithmetic progression—seems unnatural.

Before we look for the reason for this geometric progression, let us banish the idea that it is unnatural. Many things vary in a geometric fashion—or as the mathematicians would say it—exponentially.

Man's appreciation of physical things varies exponentially. Our yardsticks are proportionalities rather than fixed increments. For example, musical pitch increases in harmonics and octaves. We measure sound intensity in decibels, a logarithmic scale, because the amount we can detect as an increase is very small at low levels and very large at high levels. Our physical senses operate on a percentage increase, not on an absolute increment constant throughout the range of the quantity.

We can see this even in our appreciation of the passage of time. As we get older, time seems to pass faster, perhaps because we compare the *addition* to our experience to our *total* experience. To a man of fifty, a year is one half the relative increment in experience that is to a man of twenty-five.

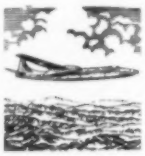
Let us note that the exponential characteristic holds in an extended time scale. Instead of plotting airplane speeds against time, let us take man's form of locomotion and plot his top speed in different centuries of his progress. In walking, foot racing, horse racing, using automobiles, airplanes, or missiles, the exponential trend is still there.

AN extreme example of this time scale comes from Richard Carrington's book, "A Guide to Earth's History":

"If we imagine the whole of earth's history compressed into a single year then, on this scale, the first eight months would be completely without life. The following two months would be devoted to the most primitive of creatures ranging from viruses to jellyfish, while mammals would not appear until the second week in December. Man, as we know him, would have strutted on the stage at 11:45 p.m. on December 31st. The age of written history would have occupied little more than the last 60 seconds of the clock."

Exponential growth, or to look at it another way—the telescoping of time—is depicted here on the ultimate scale.

At my former base in southern New Mexico, the Alamogordo and Trinity Site, I was constantly reminded of an exponential at the other extreme in time. Bombs have grown in power, from 20 to 100 kilotons up to the megaton range. The reaction that releases this power takes place exponentially, on



a microsecond time scale, as neutrons bombard atoms, releasing more neutrons, multiplying exponentially until enormous energy is released in milliseconds.

I cite these examples to prove that exponential growth is common and has a natural physical relationship.

It is very important to recognize this characteristic of the technology of our civilization at this time; first, because we must maintain the rising trend and, secondly, because we must find and encourage the sources and influences of this growth.

Considering such increases, one might despair and feel that we have to "run like crazy" just to stand still. On the other hand, a steady increase is the natural and inevitable result of the accumulation of more knowledge and more capital goods. It is like interest accruing on principal and slowly and steadily increasing the principal so that income grows exponentially with time.

The analogy between our exponentially growing technology and the growth of principal as interest is compounded can be extended to include fundamental and applied research. An exponential curve is defined as one in which the slope is proportional to the ordinate—as the ordinate increases, the slope increases.

The *slopes* of the curves, representing the growth of our technology, are obviously increasing. The *ordinate*, the ever-increasing quantity or principal, is our store or library of scientific theory and engineering know-how.

Fundamental research is the effort which increases the store—adds to the principal. Applied research is the process of mining that store—converting the theory and data to the machines of industry and the weapons of war.

More applied research can increase the slope, just as 6 per cent interest yields greater returns than 3 per cent.

But the sustaining influence, the steadily growing quantity, is the library of scientific theory and data. To continue the ever-increasing expansion of our technology and to foil Khrushchev's idea to beat us at our own game, we must add to the principal by supporting fundamental research.

It is this concept that I wish to emphasize. If we are to maintain our position in the race, we must recognize that the products of our technology, our military weapons, and, in turn, the strength of our political posture, depend on finding the source of our growth and nurturing it.

From the military viewpoint, that of the progress in performance of our weapons, we cannot stand still. A static research and development budget amidst the rising trend of technology means that we will fall behind.

"Technology has not only changed our weapons but has also changed the nature of war itself. In addition, military forces no longer oppose military forces alone. The breadth and indiscriminate character of their power is a direct threat to all from the very outset of hostilities. The American public is aware of these trends and is alarmed and concerned about our national security."

IN summary, let me emphasize that science and technology exercise a dominant influence on military weapons and on tactics and strategy. Our technology and our civilization are growing exponentially as our store of scientific theory and engineering know-how increases. To maintain our position in the world today we must take positive steps to increase our fund of knowledge by support of fundamental research.

Forty Years of Service

The American Ordnance Association, which is now celebrating four decades of dedication to industrial preparedness, is an all-partisan society that has contributed much to the defense of our country

Gen. Benjamin W. Chidlaw

THE American Ordnance Association has had a most active and worth-while year of accomplishment. Our A.O.A. publications continue to interest a growing readership. These publications are the written record of the Association. They stand, for all time, as a testimonial to the alertness, the seriousness, and the breadth of viewpoint which prevails in the great American ordnance fraternity.

Our Posts and Chapters throughout the country have been exceptionally active during the past year, and the scope of their meetings has been most impressive. I have attended dozens of such meetings from coast to coast, and I know, from firsthand knowledge, the caliber of the programs given, the interest attained, and the ultimate good they accomplish for the progress of our national weapon preparedness policies and programs.

Our Technical Divisions and Sections also have been most successful in carrying forward their important mission. These are the voluntary groups composed of representatives from industry and science who are available always to help the services with their technical problems—problems which range all the way from basic research to design and development, right on through to the production of new types.

In attending these Technical Division meetings around the country, I have seen the high degree of interest and the splendid performance of these groups. It should be a matter of extreme pride to each committee member who has given so generously of his time and effort in forwarding the program because this work one day could well be a deciding factor in victory on the field of battle, either on land, at sea, or in air. This is truly patriotism in one of its most effective forms.

Gen. Benjamin W. Chidlaw

General Chidlaw, retiring president of the American Ordnance Association, is the former commander-in-chief of the Continental Air Defense Command. He is now vice-president of Thompson Ramo Wooldridge Inc., Cleveland, Ohio. This article is based on remarks made by General Chidlaw as toastmaster at the Fortieth Annual A.O.A. Industrial Preparedness Dinner Meeting held in New York City, December 3, 1958.—THE EDITORS.

Tonight marks the fortieth anniversary of this great Association. It is not really the end, but the beginning of our fortieth year. Somewhat like the Chinese, we observed our first birthday the day we were born. We began back in October of 1919 and have traveled a great distance since then.

THE record of this Association is replete with the contributions of many outstanding American citizens who have helped write this record, and, having written it, have left for us and for all who follow us the inspiring display of faithfulness to an ideal.

This ideal is that America must always have the best in research and development of ultramodern weapon systems, an ideal which must see to it that our industrial facilities are always in constant readiness, an ideal which holds firm in the determination that our Nation must possess in adequate quantity the very best military equipment we know how to devise so that security and peace for ourselves and our brothers may be assured.

At the turn of the year I will have completed my term of office as president of the American Ordnance Association. The Board of Directors of the Association, following established pol-

icy, have chosen my successor. He is one of the most capable, the most energetic, the most highly thought-of leaders in American industry.

WHEN he assumes office, he will bring to it that leadership which has characterized his splendid career in industry and which has marked his long and faithful service to the American Ordnance Association. Our new president, for the years 1959-1960, is Louis Polk of Dayton, Ohio.

Mr. Polk is president of the Sheffield Corporation of Dayton, and vice-president and director of Bendix Aviation Corporation. He has served as a vice-president of our Association for two terms.

He was instrumental in the organization of our Technical Divisions and Committees some ten years ago, and he is presently in charge of these Divisions and Sections. He has been the driving force in bringing them to their present position of preeminence, both in achievement and in national recognition. As I get ready to relinquish the pilot wheel, there is a little touch of the valedictory, a little touch of sentimentality in the closing part of my remarks.

It is not always easy to assess personal performance. Looking back over the past year, in moments of self-analysis, one is inclined to ponder just where he might possibly have done just a little more, or a little differently, or perhaps a little better.

Despite the trials and tribulations of this somewhat hectic year of 1958, I feel sincerely that the progress of our Association, the contributions that we have made to our Nation's defense posture, the bonds of sincere friendship and understanding that we have built and maintained with all elements of our Nation's fighting forces, themselves bespeak the combined efforts of each and every one of the officers and members of our Association working as a team—for the common cause.

These efforts, these loyalties, these sacrifices of our A.O.A. team constitute the essence of our successes, and I note them with a deep and sincere feeling of gratitude.

There is one particular aspect of this Association and its work to which I am sincerely dedicated and which I have never failed to stress, in season and out, from Maine to California and, indeed, wherever any function of our organization is taking place that I could possibly attend.

The point I stress so constantly is the basic note that our Association is strictly nonpartisan or, better, it is *all*-partisan in its support of our Army, Navy, Marines, and Air Force.

The A.O.A. constitution sets forth in its opening lines the fact that we are "a patriotic, scientific, nonpolitical, and nonprofit-making organization of American citizens dedicated to scientific and industrial preparedness for the common defense as one of our Nation's strongest guarantees of national security and peace."

"AMERICAN citizens dedicated to scientific and industrial preparedness for the common defense"—this is the objective of all-partisanship. This has been our objective from the very beginning, forty years ago; this is our objective now and must always be.

Within the particular sphere of scientific and industrial preparedness operations for which our Association was basically created, the A.O.A. stands alone in that all its efforts are concentrated solely upon the progress of American weapons and weapons systems for the advantage, not of any one particular division of the Defense Department or of any one service, but for the common defense in its entirety.

We stand ready, willing, and able to help out whenever and wherever we may be called upon. We should take pride that over the years the Association has stuck closely to its knitting and has not gone afield.

I AM extremely gratified personally that during my bit of time at the pilot wheel, the wisdom of our founders has seen added vindication of this principle and, that objective of all-partisanship has been crystal clear to everyone we have worked with, thus adding to our own strength and the strength of those for whose technical progress we exist—the armed forces of our country and for American science and industry. We must always hold to this principle.

EDITOR'S NOTE.—General Chidlaw, at the conclusion of these remarks, announced the award of the American Ordnance Association's Williams Gold Medal to Vice Adm. John H. Sides.

"To make our forces adequate to counter the Russian threat requires the coordinated effort of all of us—both military and civilian. Today, wars are fought by the people as a whole—not merely by military forces. Civil-defense programs must go hand in hand with the military programs. . . . The United States has had to present a complementary arresting device to the offensive capability and become strong enough defensively to protect the American homeland—working against the shock effects of any possible air attack of a sneak and surprise nature. . . .

"The pilot in a California scramble hut and a radar operator sitting before his scope in Maine or a ground observer on a deer ranch in Wisconsin are not merely three separate Americans hundreds of miles apart. They are members of an organization bound together under the gravity of one of the most urgent responsibilities ever to face this Nation.

"This responsibility is air defense. In an age where the shattering fury of atomic attack could swing from potentiality to reality on a given word, there is no room for a 'sometimes' defense. There is no slack season, no off-market in the business of air defense.

"If we are to protect this Nation from the devastation of an atomic Pearl Harbor, we must force strength and vigilance into our framework of defense. We must be a constant force, resolutely guarding every minute of every day, whether it be the still of 3 a.m. or the rush of high noon."—General Chidlaw, as commander-in-chief, Continental Air Defense Command, writing in the March-April 1955 issue of ORDNANCE.

Science and the Military

It is not civilian control that the intelligent military man objects to but rather the constant interference with the operations necessary to accomplish the assigned missions

Lieut. Gen. Leslie R. Groves

ONE of the most serious weaknesses of our form of government is the advantage that can be taken of us by those whose aims are primarily personal aggrandizement.

Another great danger is from the superenthusiast. No one familiar with history can ignore the contrast between the enthusiast's ideas of how the next war will be fought and what actually happens when the next war comes.

The integrated effect of these two factors is to weaken our military strength. This not only lessens our chances of victory in case of war, but it more seriously increases the dangers of our becoming involved in war. One effect is the inculcation in the minds of our people of the false idea that in military matters the amateur is naturally superior to the professional. This makes possible such things as the recent effort made to take over established and successful operating agencies from the services. The effect on our military strength is bad; it can be disastrous.

TO me, it seems more important for us to be strong on this earth during the coming decades than it is to ensure that the first person-to-person interview with the Man on the Moon will be conducted by an American reporter.

It is not necessary, and I speak from experience in an era when the supply of highly trained scientists was much less ample than it is today, to disrupt going research organizations in order to establish new ones. Such attempts, whether successful or unsuccessful, have far-reaching consequences on the effectiveness of the development work of the raided organizations.

General Groves is vice-president of Remington Rand, Division of Sperry Rand Corporation, Stamford, Conn.

Scientific development, including basic research, whether in industry or government, must be for definite purposes and aimed at meeting definite responsibilities, whether these be for the national defense or for profit.

The development of the atomic bomb has made major war much less likely. But I am not sure that this is true of limited or small wars, where strength in more conventional weapons and fighting forces is vital. Our defense should be based and determined on facts and probabilities. We must not have important vital decisions governed by which presentation is the most enticing—whether to the American people or to the authorities responsible for the decision.

It is not civilian control that the intelligent military man objects to. It is the constant interference with the operations necessary to accomplish the missions which have been assigned. What the military is suffering from and has suffered from for over a decade now is this constant interference.

I would like to remind you that the wise housekeeper stays out of the kitchen when the cook is preparing dinner!

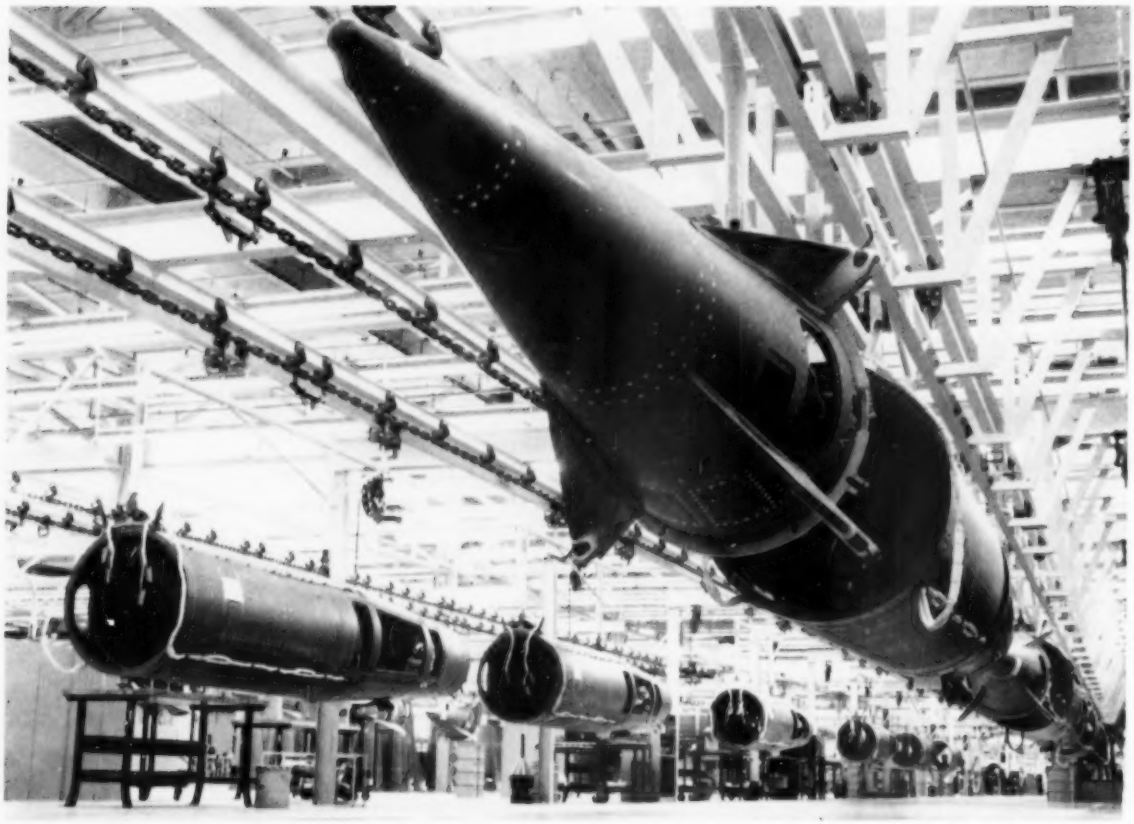
After the war ended I chose and then persuaded Dr. Norris E. Bradbury to become the head of the Los Alamos Laboratory. At that time, we had no decision from Congress or from the Administration as to what to do or how things would be conducted in the future.

Fortunately, however, unlike what seems to be the case today, we were not overwhelmed by directives and delaying indecision from above. There were no committees to which decisions had to be referred for the usual delay and lack of action.

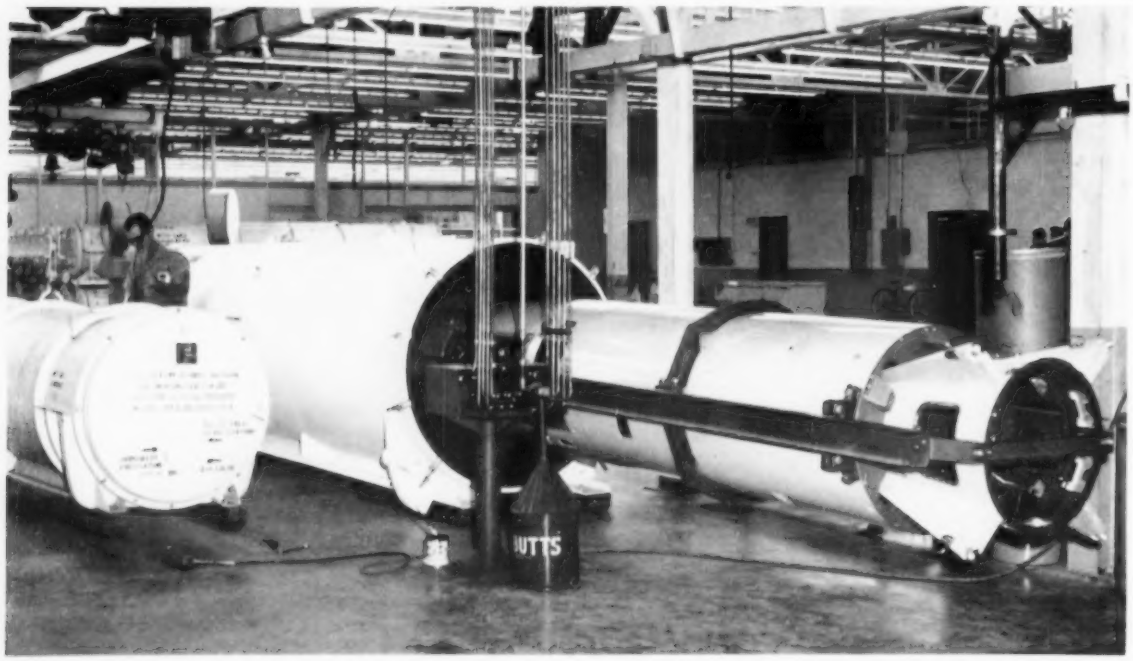
BUT there was the usual criticism to be expected after a war. Its effects upset the progress of the work and the organization, and there also was a considerable feeling among American scientists that Los Alamos should be abandoned and any future work moved to another site, "nearer to civilization," as they put it. Much of the burden landed on the shoulders of Dr. Bradbury.

After he accepted the position as head of the Laboratory, I concluded, with his concurrence, that we would remain permanently at Los Alamos. With that decision made and Dr. Bradbury at the helm, Los Alamos soon started back on the upward curve it has maintained ever since.

In the Missile Arsenal



The powerful Nike Hercules surface-to-air missile is shown above being produced on an assembly-line basis at the Charlotte Division of Douglas Aircraft Company. Below, the main section and nose cone of the missile are being loaded into a special container for shipment after assembly. Nose cone is inserted into main section in reverse to conserve space.



Defense Highlights: Monthly Review and Outlook

• **Battle of the Budget.**—Defense is entangled in a maze of budgeteering and politicking. Our legislators have millions of words to evaluate if they do not choose to accept the Administration's recommendation. Defense officials at all levels are struggling to keep military secrets as they move from closed to open hearings as well as also trying to avoid an appearance of disagreement with the Commander in Chief in their areas of special responsibility.

So far, there is veiled emphasis in congressional hearings that military leaders agree that the defense budget is adequate for this fiscal year. However, they intimate that allowance for obsolescence is meager. Each service chief hinted that his arsenal is being decreased at an alarming rate, not fully compensated by the rate of missile development. As Senator Lyndon Johnson expressed it, each military chief was saying: "Don't blame me if we take a shellacking."

• **The Logistician—A Sad Story.**—The following pertinent definition of a logistician appeared originally in *The Waggoner*, the journal of the British Royal Army Service Corps, was reprinted in *The Gazette* of the Royal Army Ordnance Corps, and was repeated with due solemnity by Maj. Gen. J. H. Hinrichs, Chief of the U. S. Army Ordnance, before a recent meeting of the Chicago Post of the A.O.A.:

Logisticians are a sad embittered race of men, very much in demand in war, who sink resentfully into obscurity in peace.

They deal only with facts, but must work for men who traffic in theories. They emerge during war because war is very much fact.

They disappear in peace because, in peace, war is mostly theory.

The people who trade in theories and who employ logisticians in war and ignore them in peace are generals.

Logisticians hate generals.

Generals are a happily blessed race who radiate confidence and power. They feed only on ambrosia and drink only nectar.

In peace they stride along confidently and can invade a world simply by sweeping their hands grandly over a map, pointing their fingers decisively up terrain corridors, and blocking defiles and obstacles with the sides of their hands.

In war they must stride more slowly, because each general has a logistician riding on his back and he knows that, at any moment, the logistician may lean forward and whisper: "No, you can't do that!"

Generals fear logisticians in war, and, in peace, generals try to forget logisticians.

Romping along beside generals are strategists and tacticians.

Logisticians despise strategists and tacticians.

Strategists and tacticians do not know about logisticians until they grow up to be generals—which they usually do—although sometimes generals will discipline errant strategists and tacticians by telling them about logisticians.

This sometimes gives strategists and tacticians nightmares, but deep down in their hearts they do not really believe the stories—especially if the general lets them have an occasional drink of his nectar.

Sometimes a logistician gets to be a general.

In such case he must associate with generals whom he hates; he has a retinue of strategists and tacticians whom he despises; and on his back is a logistician whom he fears.

This is why logisticians who become generals also get ulcers and cannot eat their ambrosia.

• **Pioneer Defines Radiation Belts.**—Americans can be gratified that Pioneer III produced excellent scientific data—which is more than can be said so far about the Russian Lunik in its propaganda dash to obscurity in the sun.

Dr. James Van Allen, of the State University of Iowa and leading American scientist in the study of radiation belts in outer space, was extremely pleased with the mass of radiation information relayed to earth by Pioneer III. He especially praised the Jet Propulsion Laboratory which developed the telemetry system and, with Collins Radio Company, designed and operated the tracking stations centered at Mayaguez, Puerto Rico, and Goldstone Lake, Calif. (ORDNANCE magazine erred in its January-February Defense Highlights—the Goldstone station was *not* blanked but tracked the probe for nine hours and recorded, along with Mayaguez, the excellent data that helped to develop the outline of the radiation belt. Sorry!)

The double check from Pioneer III flight "out and back" through 63,580 miles clearly outlined the existence of a double belt of lethal radiation—the inner from 1,400 to 3,400 miles' altitude concentrated near the equator; the outer from 8,000 to 12,000 miles' altitude extending to 50 or 60 degrees of latitude.

It would seem that the astronaut will have to navigate with care to avoid radiation belts as he blasts off for Mars—or else wear a lead suit.

• **Bidders Debriefed.**—An innovation in industry-service relations was the Air Force debriefing of Minuteman bidders. After Boeing Airplane Company was awarded this contract, unsuccessful bidders were given a detailed presentation of the reasons for the award, and their own proposals were evaluated to show the shortcomings. Minuteman is the third-generation, solid-propellant, intercontinental ballistic missile.

• **Defense Analyzed.**—The Institute for Defense Analysis

has a new president, Garrison Norton, who was Assistant Secretary of the Navy for Air until the post was abolished by the Defense Department reorganization. IDA is a nonprofit organization established by the Defense Department to analyze weapons, weapons systems, and defense plans. It undertakes tasks as directed by the Weapons Systems Evaluation Group headed by Vice Adm. J. H. Sides, and the Advanced Research Projects Agency under Roy Johnson.

Admiral Sides explained in his address at the December 3rd Industrial Preparedness Dinner of the A.O.A. that the problems analyzed by IDA, working in great secrecy, cover the most widespread aspects of the Nation's defenses. (Admiral Sides' address is published on page 730 of this issue.)

• **New Training Facility.**—Lost in the welter of great events was a noteworthy improvement in Army training facilities for high command. After the years of catch-as-catch-can existence in converted barracks, the Command and General Staff College, Fort Leavenworth, Kans., has moved into its new quarters, Bell Hall. The new building, dedicated recently by Army Secretary W. M. Brucker, is named in honor of Maj. Gen. F. J. Bell, a former Army Chief of Staff, known as "father of the modern Army school system."

• **Men for Mercury.**—Project Mercury pilots will be chosen from a select list of 110 experienced test fliers. Dr. T. Keith Glennan, Administrator of the National Aeronautics and Space Administration, announced that thirty-six "pilot-astronauts" would be named for special tests and a final group of twelve would be selected to undergo rigorous training in preparation for piloting space vehicles. He predicted the first manned flight would be in about two years after exhaustive tests with animals to ensure that all safety features are in order. The first piloted Mercury capsules will be designed for only two revolutions of the earth.

Dr. Glennan stated in answer to "beat the Russians" cries: "There would be no reward for American science in proclaiming this Nation the first to put a man in space if any mishap should occur—preventable by more deliberate planning."

Early model of the Mercury capsule configuration is in the shape of a television tube with an inflatable bag at the large end to soften the landings. The pilot rides backward and can control his reentry. Reaction jets will prevent tumbling and assist the reentry. McDonnell Aircraft Corporation, prime contractor, has engaged Collins Radio Company for electronic instrumentation and communications and Minneapolis-Honeywell Regulator to develop controls for stabilizing the capsule.

• **Junior Space Vehicle.**—Col. John P. Stapp, U.S.A.F., has proposed development of an elementary rocket-powered vehicle that could take off gradually, fly just above the atmosphere, and return the crew by parachuted capsule. Colonel Stapp, famous for his high-speed rocket-sled tests, claimed that such a vehicle is needed to train pilots for more extended trips into outer space.

• **Thermonuclear Power.**—Dr. Edward Teller told a gathering of American physicists that a thermonuclear power plant might be possible in this century. Dr. Teller, the leader in hydrogen-bomb development, lowered his time estimate on the strength of a report that the magnetic "bottling" coils used to contain the hydrogen atom plasma in experimental thermonuclear reactors could be supercooled.

Extreme low temperatures would permit building up stronger magnetic fields with reasonable power input instead of the million kilowatts now estimated to be necessary.

• **Marine Helicopters.**—The Marine Corps soon hopes to add another amphibious assault helicopter carrier to its "fleet." The PRINCETON (CVS-37) is being converted for this purpose. New designation will be LPH-5 (helicopter landing platform). The Marines now have permanent aviation helicopter detachments in the BOXER, a converted ESSEX-class carrier, and the THETIS BAY, a converted escort carrier.

• **Weather via Rocket.**—The method used for a stratospheric view of weather conditions is a splendid example of technical ingenuity. From NASA's Pilotless Aircraft Research Station at Wallops Island, off the Virginia capes, a Nike-Cajun rocket, sent 86 miles high, photographed a storm-cloud formation 1,000 miles long and extending from 200 to 700 miles off the East Coast.

The Office of Naval Research adapted a World War II gunsight camera to fit in the rocket nose cone. A capsule carrying camera and radio equipment was ejected from the rocket and recovered by a Navy destroyer-aircraft team. Over-all cost is relatively low, giving the Weather Bureau great expectations of improving storm forecasts over ocean areas.

• **Mobilization Plans.**—The Office of Civil and Defense Mobilization has been working hard to plan for America's protection. Meanwhile, American citizens enjoying their high standard of living seem to be unconcerned that they are in a war for survival—perhaps cold but assuredly vicious.

President Eisenhower has promulgated a comprehensive "National Plan for Civil Defense and Defense Mobilization" prepared by OCDM. It is to be implemented by forty annexes to cover the gamut of what we must be prepared to do in case of all-out war. Some of the annex titles: Disaster Service, Protection of Essential Facilities, Federal Delegations and Assignments, Management of Emergency Production, National Food, Shelter, Medical, and Manpower Plans.

It states: "All citizens and governments at all levels (Federal, State, local), by virtue of their inherent obligation to support the common defense, are jointly responsible for the civil defense and defense mobilization of the Nation."

That's everybody!

• **Titan Sites.**—Launching sites for the Titan ICBM are being constructed at Vandenberg Air Force Base, Calif., and Lowry AFB, Colo. The sites are to provide heavily protected underground installations to be ready in two years when the missile should be operational. All are easily pinpointed by a potential enemy, provided his earthwide mapping is any good.

Small Nuclear Weapons Progress

An Editorial

WHAT President Eisenhower has called the prevalent "hangdog attitude of humiliation" about our missile and space progress describes, unhappily, the mental condition of too many of our citizens toward other areas of our national defense as well. We are being talked into an attitude of inferiority, and this can do untold harm.

That we are making tremendous progress in missilery is true, whether or not we are behind, up to, or ahead of other countries in all matters connected with the military aspects of the conquest of space. In those areas where we have been dragging our feet we can catch up fast if we are willing to spend the money and the effort it takes.

Our national propensity for hysteria is being fostered to such an extent these days by statesmen, commentators, and headlines that the resultant popular frame of mind is playing directly into the hands of prospective enemies. Thus we are reducing the defense potential of the United States by undermining the confidence of our people in our own military-industrial strength. An enemy with the most elaborate schemes for a campaign of psychological warfare could not hope to accomplish a tenth as much with herculean effort.

And there is so much about which we can boast. The gratifying achievements in the small nuclear weapons field recently announced by the Atomic Energy Commission is a case in point. Couched in careful wording, the Commission told of a degree of weapons progress that is momentous.

In its latest semiannual report—as of January 1, 1959—the Commission states that during the two months' testing last fall at the Nevada Test Site, eleven of the nineteen shots were of very low yield, *i.e.*, one kiloton or less. The largest shot was only about twenty kilotons—what the AEC calls a "nominal yield." Shots were mostly made from balloons and underground. A few were made from towers.

THE report goes on to note that these tests were in continuation of the work of the AEC to develop a large arsenal of small-yield weapons. In its previous report (July 1958) the Commission told of three important projects in connection with its weapons development and testing programs.

One is Operation Hardtack—a test series designed to lead to the development of smaller and more efficient strategic, tactical, and defensive types with greatly reduced radioactive fallout. Another project is Operation Plumbob to provide further information relative to the design of weapons which, in the event of mishap in storage or handling, would not result in a nuclear explosion.

The Rainier Shot in this test was a 1.7-kiloton nuclear device which was fired in a tunnel in a mesa at the Nevada test site. From the Commission's 1959 report we now learn that successful results were achieved. (A complete report on this test was published by the University of California Radiation Laboratory, Livermore, Calif., and is publicly available at the Office of Technical Services, Department of Commerce, Washington, D. C., for $1.00.)

THE point we wish to make in citing this case is that here are achievements of the highest order and of vast significance for our weapons superiority. We are approaching the goal of smaller nuclear weapons—a goal which can transform military strategy and tactics in all media of combat on land, on and under the sea, in the air and in space. Yet the headline makers say little of it but keep their eyes constantly on the moon and complain that since we do not have a task force stationed thereon we have already lost whatever kind of war is in the offing!

The importance of small nuclear weapons has been stressed time and again. AEC progress in this area reflects not only that importance but is cause for real national pride in the achievement as well.

A leading proponent of small nuclear weapons is Thomas E. Murray, consultant to the Congressional Joint Committee on Atomic Energy, a member of Council of the American Ordnance Association, and formerly a member of the Atomic Energy Commission. Speaking in Washington recently, Mr. Murray stressed two points, both of which are apropos here. He diagnosed—and we think correctly—that present American public opinion is dominated by fear and by all the extremist one-sided and oversimple views that fear dictates.

The dilemma posed by Mr. Murray is indicative of how we are boxing ourselves in when we do not prosecute the small nuclear weapons programs with intensity and vigor.

"There is indeed good reason to fear tests of large weapons in the megaton range. They create dangers to health. And, as I have often insisted, they are not necessary, since our weapons strength in the megaton range has already gone beyond rational bounds. But tests of small weapons are quite a different proposition. We now know that they can successfully be carried out underground. Their effects can thus be completely controlled. No hazards result from them.

"In consequence, the Nevada test site need not be considered a symbol of menace. On the contrary, from the standpoint of reason it ought to present itself as a symbol of perfecting the technology of small weapons; and this progress cannot be assured without tests."

And so we come back to the point at which we started this comment. "Our hangdog attitude of humiliation" is absurd. Moreover, it is downright fraudulent because it is not based on fact. We would do a much greater service to peace at home and abroad if there were less distortion of our missed shots and more pride when we hit the target. Our small nuclear weapons progress, we repeat, is a good case in point. We can all take pride in the success thus far and assert our confidence that we will win out.

Manual for Technical Operations

A guide for A.O.A. Divisions in their support of Government agencies

A REVIEW of the progress made by the Technical Divisions of the American Ordnance Association coupled with the need for more uniform management procedures has resulted in a new Technical Operations Manual. Prepared by the Headquarters' staff with the assistance of Division and Section chairmen, the new manual has been printed and is in the process of being distributed.

Based on eleven years of operations, the manual provides an all-inclusive guide to A.O.A. Technical Division members through comprehensive coverage of each phase of their operations. The general objectives of the manual are to bring the Technical Division organization into line with the current interests of Government and industry as well as to establish the capability for more effective support of all Government agencies concerned with defense and space programs. It also hopes to secure wider participation for all qualified A.O.A. members in the activities of the Technical Divisions.

Additional procedures are included to provide guidance on improving the quality of technical meetings and to establish funding arrangements in order to provide a measure of self-support for technical activities. By better distribution of technical papers and reports, more effective mutual support among the Divisions will be promoted.

THE manual lists the following main items: Organization, Scope of each Division and Section, Program Guidance, Membership, Meeting Arrangements, Security Procedures, Public Relations, and Check List for Division Meetings.

The first item on Organization delineates the specific duties and responsibilities of each officer and chairman within the Technical Divisions. It establishes an Executive Technical Board to assist the vice-president in charge of Technical Divisions, the general chairman, and the staff director in planning and coordinating all technical operations. An additional part of the Organization item lists each Technical Division and requires that it contain the necessary number of Sections to cover the Division scope. Each Division or Section chairman will have management responsibility and authority for controlling his Division or Section, under the guidance of the manual.

With new organization, the manual divides the Technical Divisions into two categories. Those concerned with development, production, and logistics of weapons, armament, and support equipment are designated Commodity Divisions. The Technical Support Divisions cover the research, materials, processing, and techniques of wide application.

Complementary in operation, the Technical Support Divisions assist the work of the Commodity Divisions through meeting participation and preparation of special studies. The manual lists the following component Commodity Divisions: Artillery; Bomb, Warhead, and Artillery Ammunition; Combat and Tactical Vehicle; Electronics; Fire Control Instrument; Missiles and

Astronautics; Small Arms and Small Arms Ammunition; Underwater Ordnance. There are five Technical Support Divisions: Materials; Packing and Handling; Production Techniques; Research; Standards and Metrology.

THE specific scope of each of the component Divisions is supplemented by a listing of general objectives. Through a mutual exchange of technical, scientific, and engineering information by industry and Government agencies, industry will continue to be informed as to the military requirements and Government will know the capabilities and achievements of science in industry. They also will emphasize approaches to development, design, and production in the general aim to promote reliability in operation and economical production.

Exclusive of procurement and contractual problems, the Divisions will develop solutions for technical and management difficulties which broadly determine the effectiveness and efficiency of the armament industry and its working relationship with Government agencies. Another general objective is to provide Government agencies with industry's opinion and reaction to proposed solutions, operational procedures, standards and specifications relating to the development and manufacture of weapons and support equipment. By being alert to technological advances and break-throughs in all fields related to ordnance and other armament, Technical Division members can suggest appropriate action to the Defense agencies.

The item on Program Guidance states that interesting and timely programs are a necessary part of the effectiveness of A.O.A. technical operations. It also describes operational procedure for each type of meeting, whether of the Executive Board or of a Section Steering Committee.

The qualifications of Division members and officers are discussed in the item on Membership. It also covers the selection of consultants, a position restricted to military officers or civilian personnel from Government agencies.

A separate item includes directions for meeting and funding arrangements with the criterion that the meetings must be of a caliber that will justify the expenditure of the time and money involved. The chosen facility and its personnel should have a definite relation to the subject of the meeting.

Since Technical Division meetings are often classified, an item on Security Procedures gives detailed and careful instructions as to how clearance may be obtained. A sample of the Security Form is included in the manual for further clarity.

Because of the number and variety of the Association's Technical Division and Section meetings, there is an outstanding opportunity for attracting widespread publicity as to the work and objectives of the A.O.A. The method by which this is to be carried out is fully described in a separate item on Public Relations.

A check list for Division meetings shows the general approach which should be taken in the preparation and operation of each meeting. This includes a time-phased check list and a sample of a meeting agenda.

MEMBERS of A.O.A. Technical Divisions will receive a copy of the manual as well as officers and directors of A.O.A. Posts and Chapters and the managerial personnel of company members. Distribution also is being made to key personnel in the interested Government agencies. Other A.O.A. members may request a copy of the manual and application forms by writing to A.O.A. Headquarters, attention General Mechling, Staff Director for Technical Operations.

ASSOCIATION AFFAIRS

Philadelphia Post Has Great Success With Its First Technical Symposium

The Philadelphia Post had spectacular success with its first technical symposium on November 17th. The meeting was planned as the first of a program in fields of special industrial or technical interest. It was arranged for maximum appeal to younger engineers and executives with emphasis on the subject matter and with the minimum of fancy trimmings. Instead of the expected audience of 250, over 350 members attended. "Quality Assurance" was selected as the initial seminar subject.

At Philadelphia Post symposium were, left to right: Brig. Gen. James A. Richardson, III, commanding Frankford Arsenal; Weber deVore, Post president; Dr. John S. Burlen, executive vice-president of Franklin Institute; and Brig. Gen. F. J. McMorrow, Chief of the Industrial Division, Office of the Chief of Army Ordnance.

The active leaders who proposed and developed this meeting in addition to Weber deVore, Post president, were C. L. Eksergian, engineering vice-president of Budd Company, a director of the Post and chairman of the Association's Missiles and Astronautics Division, and Col. H. C. Thayer, formerly commanding officer, Philadelphia Ordnance District. The Department of Defense, Army Ordnance, and industry cooperated vigorously.

The Franklin Institute cosponsored the symposiums, held in Franklin Hall at the Institute. Dinner started promptly at 6 p.m. and preliminaries were concluded by 7:20 p.m.

The introductory phase, with Mr. deVore presiding, opened with a welcome from the host, Dr. John S. Burlen, executive vice-president of Franklin Institute. Mr. deVore presented the special guests, Post directors, and panel speakers and read a telegram from the Hon. Perkins McGuire, Assistant Secretary of Defense, Supply and Logistics.

The theme of the symposium was set by Brig. Gen. F. J. McMorrow, Chief of the Industrial Division, Office, Chief of Army Ordnance, who defined quality assurance as viewed by the Department of Defense and discussed the broad aspects of the problem and the objective—providing combat units with equipment of the required reliability. He stated that the intent is "to require manufacturers to plan for, develop, and implement quality assurance plans adequate for control of product quality throughout production."

Brig. Gen. James A. Richardson, III, who commands Frankford Arsenal and was a prime mover in organizing the panel, then took the chair and introduced the panel moderator, John J. Riordan, staff director of inspection and quality control in Secretary McGuire's office.

The talks by each panel member were especially noteworthy for the skillful manner in which they were integrated. Each speaker presented his viewpoint of quality assurance so that the field was covered by the Defense Department, the three services, and industry with due acknowledgment of previous remarks and the minimum of repetition.

Mr. Riordan clarified the relationship of quality control and reliability, discussed the means by which he believed industry could incorporate better the two functions in their operations, and described the Defense Department publications that regulate quality assurance.

Phillip S. Pyle, chief of the Quality Control Division, Philadelphia Air Procurement District, covered the specific field of the Air Force specification that prescribes quality-control procedures required of contractors. He emphasized that an effective attitude, knowledge, and skill in quality on the part of all manufacturing personnel will ensure a quality product and reduce the burden of a large inspection force.

Fred Van Sant, Jr., deputy chief, Inspection Division, Philadelphia Ordnance District, compared the wastefulness of present inspection methods with the results obtainable under the quality-assurance concept.

Lee Dunlap, quality control administration, Office of the Inspector of Naval Material for Eastern Pennsylvania, discussed the new procedures to reduce paper work in the inspection of subcontractors' material.

Dr. Clifford M. Ryerson, reliability program administration, Defense Electronic Products Division, Radio Corporation of America, presented the point of view of many industries which agree with the theoretical concept of quality assurance but find many pitfalls and difficulties in the practice as prescribed by Government bureaus.

Among distinguished members and guests were: Col. Henry N. Marsh, a national vice-president and director and a director of the Post; Col. A. W. Gilmer, chief of the Philadelphia Ordnance District, a Post director and former president; Col. J. K. Warner, U.S.A.F., chief of the Philadelphia Air Procurement District; S. J. Lorber, chief, Industrial Inspection Section, Office, Chief of Ordnance; William F. Rathgeber, Jr., Post secretary-treasurer; Emil Mathias, chief of quality control, Frankford Arsenal.

The following members of the Post's board of directors also were present:

C. Jared Ingersoll, wartime chief of the Philadelphia Ordnance District; W. J. Meinel, L. C. Allenbrand, G. H. Brown, Paul Gant, Vincent deP. Goubeau, Horace C. Knerr, Richard Nalle, Martin Sandler, E. B. Webster, past president of the Post, Dr. I. Melville Stein, and Henry Dever.

EDITOR'S NOTE: *All Posts should heed this splendid example set by our Philadelphia members under the energetic leadership of their president, Weber del'Orc. All Posts need programs of technical interest that will appeal to the younger engineers and executives. Philadelphia has shown the way! A.O.A. Headquarters and chairmen of our Technical Divisions are ready to help.*

Members Of Far East Post Participate In Tour Of Japanese Automobile Works

Members of the Far East Post recently were treated to a visit to the Isuzu Motors Company, Kawasaki, Japan. The trip was arranged through the courtesy of the Japan Ordnance Association, modeled after the A.O.A., with which the Far East Post has established cordial relations.

Over forty-five members made the tour, led by Post President Robert Hageman. The Isuzu motor works are typical of the extensive technical and industrial advances made by Japanese industry since World War II. The A.O.A. guests first observed the manufacture of all the subassemblies and then traveled to the assembly line where trucks and passenger cars were moving at a rate equal to the best in the Detroit area.

Value Engineering Committee Plans Production, Research And Development Seminars

The seventh meeting of the Ad Hoc Committee for Value Engineering, Underwater Ordnance Division, took place on November 20th in the Main Navy Building, Washington, D. C. Future plans centered on a production seminar and a research and development seminar to be held this year. It was agreed to approach the Navy Bureau of Ordnance in order to obtain problem projects for discussion. This will be in line with methods of fostering and instituting increased value engineering effort in the Navy Bureau of Ordnance, its field activities and contractors, and industry at large.

Standards And Metrology Group Meets At U.S. Naval Ordnance Test Station

Members of the Standards and Metrology Division and defense agency consultants attended a 2-day meeting on January 14th-15th at the U. S. Naval Ordnance Test Station, China Lake, Calif. Outgoing Division Chairman, Louis Polk, newly elected A.O.A. president, opened the meeting and introduced his successor, Thorpe Thompson, Cleveland Instrument Company.

After Capt. W. W. Hollister, U.S.N., welcomed conferees to the Test Station, L. J. Paddison, director of reliability development, Sandia Corporation, Albuquerque, N. Mex., discussed "Some Significant Aspects of Reliability Development in Nuclear Weapons." As Mr. Paddison traced the operations of the Sandia Corporation in securing improved reliability by means of assured precision, he explained the need for this Division to provide support in other standards fields in addition to the dimensional field.

Representatives from each of the military services presented their general philosophy of operation and means for providing reliable checking of field standards and calibration equipment throughout the services and industry. A paper prepared by Col. J. G. Schneider, U.S.A.F., Chief of Quality Control, Air Matériel Command, on "Modern Weapons Systems Demand Dynamic Calibration Programs" was presented. The Navy viewpoint was given by Comdr. Herbert L. White, Chief, Gage Control Division, Naval Gun Factory, in his talk on "Navy-Contractor Integrated Gage Programs."

A supplementary talk was presented by Lieut. Clyde R. Brewer, assistant gage officer, Inspection Equipment Division, Naval Gun Factory, on "The Navy Ordnance Calibration Program." In his report on "Army Ordnance and American Gage Design Standards," M. L. Fruechtenicht, manager, Gage Department, Frankford Arsenal, outlined the Army's experience with dimensional standards. It was demonstrated that each of the services uses the National Bureau of Standards for periodic checking of major field standards.

A. G. McNish, consultant to the Director, National Bureau of Standards, explained "The Basis of Our Measuring System," with increased emphasis on substituting physical constants for more artificially chosen standards. This already has been done for the standard of temperature, and it can be used advantageously for the standards of length and time, but there seems to be no way adequately to replace the standards of mass.

In his talk on "Missiles and Quality Assurance," Robert W. Cuthill, chief engineer, Army Ordnance Missile Command, Redstone Arsenal, Ala., discussed the problem of quality assurance as related to missile reliability. He presented the organization and policies of the Ordnance Missile Command and emphasized that we still have much to achieve in missile reliability. A full understanding of the application of standards and metrology is one of the major approaches to improved reliability.

One of the practical technical studies stimulated by this Division was outlined by I. H. Fullmer, chief, Engineering Metrology Section, National Bureau of Standards, in his "Large Scale Metrology Report." This involved the preparation of three castings ranging from thirty to eighty inches in diameter and having

Louis Polk, center, new A.O.A. president, confers with John Cox, left, chairman of the China Lake Chapter of the Los Angeles Post, and Capt. W. W. Hollister, right, commander of the Naval Ordnance Test Station, China Lake, Calif.

these measured in the field by some eight Government and industrial organizations. These castings are measured periodically by the Bureau of Standards, with careful analyzation of the results. The analysis to date gives interesting information on the variation in measurement that can be expected among different operating agencies.

On the following day, Dr. William B. McLean, Technical Director, Naval Ordnance Test Station, gave a full briefing on the organization facilities and the work of the Test Station, stressing the importance of its research and development functions. The conference then moved to the Station test ranges for a full program sponsored by the facility.

The August meeting of the Executive Technical Board of the A.O.A. in Cleveland, Ohio, authorized this Division to broaden its scope to include additional standards and related metrology techniques required in the design and production of modern complex weapon systems. In addition to dimensional standards, the Division plans to cover time, electrical, mass, optical, and other physical standards. To facilitate this expansion, the Division will have three Sections—Dimensional Standards, Electrical Standards, and General Physical Standards.

Under the leadership of Mr. Polk, the Standards and Metrology Division, working with defense agencies and the Bureau of Standards, has been effective in improving dimensional standards and in stimulating application of advanced metrology techniques to the design and production of ordnance during the past fourteen years. The work has culminated in the Bureau of Standards establishment of the standard inch, in conjunction with Great Britain and Canada.

Middle Tennessee Chapter Members Visit Engineering Development Center

Members of the Middle Tennessee Chapter of the Cincinnati Post traveled from their headquarters in Nashville to Tullahoma, Tenn., to visit the Arnold Engineering Development Center of the Air Research and Development Command on November 12th.

More than 60 of the 250 members of this Chapter, led by F. Donald Hart, chairman, were guests at luncheon at the officers' mess. They were welcomed by Maj. Gen. Troup Miller, Center commander, who briefed them on the mission, present activities, and future developments of his command.

The afternoon was devoted to an inspection of the extensive layout of laboratories and wind tunnels. At the Engine Test Facility, the Dynamics Facility, and the Propulsion Wind Tunnel, scientists and engineers gave enthusiastic demonstrations of current activities. They described such matters as testing the X-15 rocket research aircraft, the operation of variable nozzles in the hypersonic wind tunnel, and testing full-scale sections.

Dr. H. Perry, left, Arnold Engineering Development Center scientist, discusses scale model of the X-15 rocket research aircraft with F. Donald Hart, center, president of the Middle Tennessee Chapter, and Maj. W. W. Higbee, U.S.A.F.

Milwaukee Post Elects New Officers And Plans To Increase Group Activity

New officers and directors of the Milwaukee Post were installed on Friday, January 9th, during a meeting held at the Milwaukee Club. Algie A. Hendrix, assistant manager of the AC Spark Plug Division of General Motors in Milwaukee, was named president, succeeding Jacobus Kruyne, Loewi & Company. Other officers installed were: W. C. Messinger, Chain Belt Company, vice-president, and Alvin B. Goodspeed, AC Spark Plug, secretary-treasurer. Retiring Vice-President Fred W. Hansen, of Evans-Hansen, was instrumental in a recent move to increase Post activity.

In assuming his new office Mr. Hendrix paid tribute to the roles of the two retiring officers in advancing the work of the Milwaukee Post locally and nationally. "Mr. Kruyne has done an outstanding job in stimulating interest in the work of the Milwaukee Post among Wisconsin's industry leaders," he said. "He also has made a valuable contribution to the organization as a member of its national Council. Mr. Hansen, one of the founders of the Post in 1928, has a notable record of service in his long association with the A.O.A. The spirit and experience of both of these men will be a great help to the new officers of the Post."

Industry was called the "fourth arm of our national defense" by Col. Leo A. Codd, executive vice-president of the A.O.A., who attended the meeting to assist in the installation ceremonies. He said industry shares this role equally with our Army, Navy, and Air Force. "American industry—and especially the industry of Milwaukee—is a vital part of our national security. Its role is constantly increasing," he concluded.

Directors elected at the meeting for terms of three years are: R. R. Walker, Allis-Chalmers Manufacturing Company; Hubert Barnes, A. O. Smith Corporation; S. A. Halpern, National Presto Industries, Eau Claire; Mr. Hendrix and Mr. Goodspeed. Directors for two years are: H. Stanley Johnson, Jr., Gisholt Machine Company, Madison, Wis.; W. G. Prasse, Oilgear Company, Milwaukee; Robert A. Uihlein, Jr., Schlitz Brewing Company, Milwaukee; Harold Falk, Jr., Falk Corporation, Milwaukee; Mr. Messinger and Mr. Hansen. Those serving for one year are: Leon R. Clausen, J. I. Case Company, Racine, Wis.; J. E. DeLong, Waukesha Motor Co., Waukesha, Wis.; W. C. Heath, W. C. Heath Associates, Milwaukee; E. J. Beaver, Kohler Co., Kohler, Wis.; and Mr. Kruyne.

Michigan Post Hears General Everest At Annual Dinner Meeting In Detroit

The Michigan Post's annual dinner meeting for 1958 was held in the grand ballroom of the Sheraton-Cadillac Hotel in Detroit on Wednesday, December 10th. Leaders of industry from throughout the State of Michigan gathered almost 700 strong in a sparkling affair to pledge anew their support of armament preparedness and the A.O.A.

Gen. Frank F. Everest, Commander, United States Air Forces in Europe, and Commander, Fourth Allied (NATO) Tactical Air Force, the guest of honor, was introduced to all the leaders of the Association in Michigan at a reception preceding the dinner.

Toastmaster Edward N. Cole, a vice-president of General Motors and a director-elect of the Michigan Post, welcomed the guests, introduced the newly elected directors, and called on Capt. J. M. P. Wright, A.O.A. Headquarters, for a word on national Association affairs. Louis E. Moultane, Post president and presiding officer, reported on the year's activities of the Post, the largest in the Association, and exhorted all to give the Membership Committee full support in achieving a steady growth for the Post. He announced his successor as president to be Mervyn Gaskin, formerly first vice-president of the Post.

New directors for 1959 introduced were: Edward N. Cole, General Motors Corporation; Talbert Abrams, Abrams Instrument Corporation; Kenneth B. Coates, chief, Detroit Ordnance District; William E. Grace, Fruehauf Trailer Company; and Robert O. Greenshields, Budd Company.

General Everest spoke on the importance and effectiveness of the NATO forces in Europe, explaining that they have great capacity to respond with a wide variation of military actions in case of Communist pressure. Otherwise, he noted, if we had only a retaliatory force, small aggressions would succeed by default for fear of launching a global war.

The general expressed the belief that global war was extremely unlikely since victory would be impossible for either side and the Communists firmly believe that eventually the free world will collapse. He warned, however, that our deterrent strength must be maintained and our will to hold the line, as in the Quemoy Islands attack, remain strong.

At the head table, in addition to those already mentioned, were: Dr. John A. Visser, minister, Westminster Presbyterian Church, and Post chaplain, who delivered the invocation; Robert L. Biggers and S. E. Skinner, national directors of the A.O.A.; Col. Herbert R. White, regional vice-president, A.O.A.; Col. Irving L. Duffy and Britton L. Gordon, members at large of the national Council; Henry T. Bodman, James Fulks, and Del S. Harder, past presidents of the Post; and Joseph A. Anderson, Post vice-president.

Also, Maj. Gen. N. M. Lynde, Jr., commanding the Ordnance Tank-Automotive Command; Maj. Gen. R. E. L. Eaton, commander, Tenth Air Force; Brig. Gen. C. T. Edwinson, commander, 30th Air Division; Capt. C. A. Keller, commanding the Naval Air Station, Grosse Ile, Ill.; Col. W. A. Call, deputy commander, Ordnance Tank-Automotive Command; Col. J. E. Johnston, commanding officer, Detroit Ordnance District; Capt. E. W. Logsdon, inspector of naval material; Col. J. W. Romelin, commanding the 28th Artillery Group, Air Defense Command.

Also the following members of the Post Advisory Committee: Irving J. Minet, Chrysler Corporation; Bronwer D. McIntyre, Monroe Auto Equipment Company; William J. Athanson, Jarecki Corporation; E. Howard Perkins, Brooks & Perkins, Inc.; J. Frank Forster, Vickers, Inc.; F. Russell Valpey, Standard Products Company; and William A. Mayberry, Manufacturers National Bank.

Also the following directors of the Post: C. Jack Reese, Continental Motors Corporation; John Dykstra, Ford Motor Company; Guy S. Peppiatt, Federal-Mogul-Bower Bearings, Inc.; Simon D. Den Uyl, Bohn Aluminum Corporation; Lester R. Downie, Kelsey-Hayes Company; and Arthur W. Wild, Continental Aviation & Engineering Company.

Also the secretary of the Lansing Chapter, Earl J. Duke, and the hard-working secretary-treasurer, Charles W. Brownell.

College Chapter Of Lone Star Post Has Fine Program Of Activities

The Agricultural and Mechanical College of Texas Chapter of the Lone Star Post, American Ordnance Association, is the largest Chapter of its kind in the Nation. It is a student Chapter with over one hundred and forty members—young men who will someday be our industrial and scientific leaders.

At recent Texas A. & M. Chapter meeting were, left to right: Capt. Wilbur A. Wilson, faculty adviser; Cadet Maj. James W. Best, vice-president for committees; Cadet Lieut. Col. Thomas E. Reddin, president; Brig. Gen. Horace F. Bigelow, Assistant Chief of Ordnance for Manpower; Cadet Capt. Jack N. McCrary, vice-president for activities; Lieut. Col. Harold A. Nelson, St. Louis Army Ordnance District.

The interest of the cadets at Texas A. and M. in the A.O.A. is no accident or passing college fad—they realize that a strong America is a prepared America and that ordnance development is the key to our preparedness.

Texas A. and M. is an all-male school located at College Station, Tex. Its seven thousand students are organized into fifty R.O.T.C. companies. Because of its compulsory military training, A. and M. is rich in the tradition that only a military school can have. The "Aggies" have always been proud of their military record and point with pride to the fact that A. and M. furnished more officers in World War II than any other school, including West Point. It is not surprising, then, that the students feel as they do about preparedness for defense.

In the latter part of 1956, five students of the Ordnance Company at A. and M., aided by Col. H. Ross Jordan, U.S.M.C. (Ret.), of Chance Vought Aircraft and

national Councilman of the Lone Star Post, organized the student Chapter as part of the Lone Star Post. On February 1, 1957, Maj. Gen. John B. Medaris, Commanding General, Army Ordnance Missile Command, presented the charter to the new Chapter and its fifty charter members—now tripled in number.

Highly active, the Chapter meets monthly to hear guest speakers. The most recent speaker was Brig. Gen. Horace F. Bigelow, Assistant Chief of Army Ordnance for Manpower. General Bigelow's talk compared a job with the Ordnance Corps with a job in industry. It was an enlightening talk, well received by the members. Besides the student membership, guests present were Brig. Gen. Volcansek, U.S.M.C. (Ret.), Texas Instruments, Inc.; Col. J. E. Davis, commandant of Texas A. and M.; Lieut. Col. Taylor Wilkins, assistant commandant; Capt. Wilbur A. Wilson, sponsor of the student Chapter and a director of the Lone Star Post; and Colonel Jordan.

In addition to its prominent guest speakers, the "Aggie" student Chapter takes part in other outside activities. Its officers attend Lone Star Post meetings, and in the spring of 1958 the entire membership made a field trip through the plants of Texas Instruments, Inc., and Chance Vought Aircraft, Inc., both located in Dallas.

Constant activity combined with the natural interest of the cadets in the civilian and military teamwork required for preparedness explains the large size of the Chapter. America's future is assured with young men such as these who are constantly moving into positions vital to our preparedness. Texas A. and M. and its student Chapter are doing their part to safeguard our country's future.

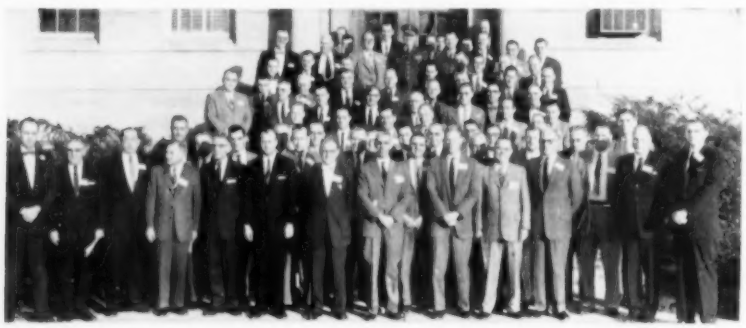
Powder Metallurgy Group Holds Exhibit And Meeting At Frankford Arsenal, Pa.

The A.O.A. Powder Metallurgy Committee displayed its wares December 1-2, 1958, at Frankford Arsenal, Philadelphia, Pa. In conjunction with an unusual 2-day session of this active technical Committee (now a Section) an especially elaborate exhibit of the metal-powder process and its application to Ordnance as well as to industrial problems was displayed.

With the support of Maj. Gen. August Schomburg and the cooperation of his staff, an executive meeting of the Committee was arranged for the commanding officers of various Ordnance installations either currently concerned with powder metallurgy production or interested in determining its applicability to their problems.

This meeting, educational in nature, highlighted the advances of the powder-metallurgy industry and emphasized to the Army, Navy, and Air Force representatives not only that powder metallurgy has for many years produced many Ordnance components upon which the defense services have been able to rely with confidence, but also highlighted the importance of constant review of the technical developments within this industry as a means of making the most effective use of the process in its application to improved design and to the development of new Ordnance items.

Members reviewed the unique method by which this Committee has for nearly three years conveyed its technical message to Ordnance through the use of a "Task Force Group." This group, consisting of design engineers from all three defense services, carries out a constant program of plant visitations for the purpose of observing the production of metal powders and the fabrication of these materials into a wide variety of end products.



Shown above are members of the A.O.A. Powder Metallurgy Committee during their 2-day meeting at the Frankford Aresnal, Philadelphia, Pa., to discuss new methods.

Information thus obtained has been disseminated by the group members among interested design and production engineers in their own installations with the result that a working knowledge of powder metallurgy has been made available where it counts. The success of this program, which is expected to continue indefinitely, was verified by the declared intention to augment the Task Force Group by the addition of representatives from other installations who would like to take better advantage of the powder-metallurgy capability.

Following the executive meeting, over 100 industry and Government representatives attended a full technical session of the Committee. Some of the latest developments in the use of powder metallurgy were presented. Reports on techniques for the rolling of tungsten sheet and for the fabrication of beryllium were given by experts in these fields. A technical review of the progress made in the development and production of iron powder and of parts made from iron powder clearly established the rate at which this technology has grown.

Further developments in the use of the slip-casting technique and of the many applications for metallic flake powders highlighted the applicability of powder metallurgy to fields other than the pressing and sintering of structural parts with which the process is most commonly associated.

As a result of his recent survey trip through Western Europe, the chairman of the Committee compared developments in European powder metallurgy with American practices. The Task Force Group demonstrated its grasp of the powder-metallurgy technology by its able reports on developments, particularly in the field of ammunition components, which they have carried out with the cooperation of industrial members of the Committee.

The educational character of this meeting and display of powder metallurgy emphasized the usefulness of this process in satisfying a number of the production criteria connected with the manufacture of military items. Members established that: (1) Powder metallurgy effectively reduces the number of highly trained personnel required in many cases; (2) The consumption of strategic raw materials is often drastically reduced, if not eliminated, by the substitution of non-strategic material made possible by the obtaining of unique physical properties through this process; (3) The release of conventional equipment, such as machine tools, which may be critically needed on other production programs, is frequently made possible; (4) Lead times from

design through production and into manufacture are invariably reduced, in many cases, from periods of several months to periods of a few days or weeks; (5) Production costs are reduced by virtue of the elimination of manufacturing steps and of the mass-production capability of this method; (6) Ordnance often is able to obtain by the powder-metallurgy method parts or unique products not obtainable by any other known method of fabrication.

Albuquerque Post Holds Winter Meeting; Hears Report On The Polaris Program

The Albuquerque Post's winter meeting was held at Sandia Base Officers' Club on Tuesday, January 6th. There was a large turnout to hear Comdr. George F. Moran, Planning Division, Special Projects Office, Navy Bureau of Ordnance, report on the Polaris missile program.

Attending Albuquerque Post meeting were, left to right: Col. Irving L. Branch, Deputy Commander, Air Force Special Weapons Center; Maj. Gen. L. T. Heath, Commander, Armed Forces Special Weapons Command; Comdr. George F. Moran, guest speaker; and Rear Adm. Courtney Shands, Deputy Commander, Armed Forces Special Weapons Command.

J. J. O'Connell, post president, as presiding officer introduced the guests at the speakers' table who included: Lieut. Comdr. A. P. Spohn, Chaplain, U.S.N., who gave the invocation; Maj. Gen. L. T. Heath, Commander, Armed Forces Special Weapons Command, and his deputy, Rear Adm. Courtney Shands; Col. Irving L. Branch, Deputy Commander, Air Force Special Weapons Center, Kirtland Air Force Base; W. W. Jackel, vice-president, nuclear products, Erco Division, ACF Industries, Inc., Albuquerque, N. Mex.

Commander Moran said Polaris definitely will be successful and the Navy believes technical barriers have been surmounted. Remaining problems are those of engineering and refinement, he added.

He said the recent destruction of two full-sized missiles was a safety measure and that "we have learned certain elements—the critical ones—proved the soundness of their design." The commander said the components which caused the failures were minor and certain features are being reengineered.

In event of war an enemy would be faced with accepting retaliatory annihilation by long-range weapons or with tracking down and destroying them in advance. This would most certainly "tip their hand" as to their aggressive intentions.

Secretary Higgins Is Guest Of Honor And Speaker At Birmingham Post Meeting

Hon. Frank H. Higgins, Assistant Secretary of the Army, Logistics, was guest of honor and principal speaker at the Birmingham Post's annual dinner meeting on Friday, January 23rd. A record crowd of almost three hundred members and guests packed the Birmingham Country Club to greet the Secretary.

Post President A. B. Schwarzkopf, presiding, announced the recommendations of the nominating committee which were unanimously approved. Warren Whitney, a former Post president, introduced the guests at the speakers' table and called on Col. Leo A. Codd, executive vice-president of the A.O.A., to present the Association's certificate of appreciation to past Post President Richard M. Donahue.

In his address, Secretary Higgins warned that America's industrial might is faced with a serious challenge from foreign production. He said Russia is now approaching fifty per cent of the United States' gross national product—the total of goods and services produced annually.

The speaker noted that Japan, "a new ghost on the horizon," has factories more modern than some of ours. He pointed out that at one auto factory, Japanese workers receiving fifty cents an hour are producing one third more than American workers. As a result, our government "could buy a 2½-ton truck from Japan for less than half what it would cost from an American factory."

Citing the United States-Canada combine as the world's number one "energy center," Secretary Higgins ranked Western Europe in second place, followed by

Assistant Secretary of the Army Frank H. Higgins, second from right, chats with Charles S. Lawson, left, past chief of Birmingham Ordnance District; Col. W. J. Rushton, district chief; and A. B. Schwarzkopf, left, newly elected president of the Birmingham Post during the annual dinner meeting of the Post.

the Sino-Soviet bloc and Japan. He emphasized that in today's world, economic might goes hand in hand with military might, and the United States is "threatened with a loss of her advantage in both." Militarily speaking, "we've got to be ready for large and small wars, and ready tomorrow."

Distinguished guests of the Birmingham Post were: Maj. Gen. John B. Medaris, Commanding General, U. S. Army Ordnance Missile Command, Redstone Arsenal, Ala.; Brig. Gen. Gunnar Carlson, Office, Chief of Army Ordnance, Washington, D. C.; Maj. Gen. Walter J. Hanna, Air National Guard, Birmingham; Col. William A. Davis, Commanding Officer of the Birmingham Ordnance District and a newly elected director of the Post.

Also present were the majority of newly elected officers and directors. Post officers are: J. Frank Curry, vice-president; Robert D. Cotton, treasurer; Ralph E. Parker, secretary. The following are Post directors: J. Lindsay Builder, Richard M. Donahue, Paul Barton, Roy D. Hickman, Thomas E. Kilby, Jr., P. S. Knox, Jr., Col. H. G. Lang, Claude S. Lawson, Winston B. McCall, K. B. McMasters, Russell H. Pedigo, Merrill E. Pratt, Herbert E. Smith, Jr., Arthur V. Wiebel, Warren Whitney, and Col. William A. Davis.

Large Crowd Hears Secretary Higgins At Chattanooga Chapter Dinner Meeting

The Hon. Frank H. Higgins, Assistant Secretary of the Army—Logistics, was the guest of honor and principal speaker at the dinner meeting of the Chattanooga Chapter of the Tennessee Valley Post held on January 8, 1959. With nearly 400 members and guests attending, this meeting, held in the Hotel Patten, Chattanooga, was one of the largest and most enthusiastic events held by an A.O.A. group in the South.

Secretary Higgins was greeted at the Chattanooga airport by a welcoming committee headed by P. R. Olgiati, mayor of Chattanooga; Hon. Wilkes T. Thrasher, judge of the Hamilton County Court; Lawrence Skelly, Chapter Chairman; and Frank Kollmansperger, president of the Chattanooga Chamber of Commerce.

The party then embarked in a fleet of automobiles, and enroute to Chattanooga visited the McCallie military school for boys where a brief stop was made while Mr. Higgins inspected an honor guard of the young cadets. The group later visited the reactor division plant of Combustion Engineering Corporation where huge pressure vessels, to be used in the nuclear reactors of our modern aircraft carriers and submarines, were being constructed.

The dinner meeting at the Hotel Patten began with a reception of all members by the distinguished guests including Mr. Higgins; R. W. Cuthill, president of the Tennessee Valley Post; Maj. Gen. F. A. Hansen, Assistant Chief of Army Ordnance for Field Service; and Col. W. B. Latta, Chief, Material Maintenance Office, Deputy Chief of Staff—Logistics.

Rear Adm. A. F. Richardson, program chairman of the Chattanooga Chapter, as toastmaster presented Dr. J. L. Fowle, pastor of the First Presbyterian Church, Chattanooga, who gave the invocation. After introducing a number of the distinguished guests present, Admiral Richardson then called on Mayor Olgiati, who extended the city's welcome to the A.O.A. group. Roger E. Lewis, representing the national headquarters of the Association, spoke briefly on the purposes of the A.O.A., and W. C. Hudlow, chairman of the Chattanooga Industrial Committee of 100, outlined the manufacturing advantages of the Chattanooga area.

Attending Chattanooga Chapter meeting were, left to right: R. W. Cuthill, president of the Tennessee Valley Post; H. F. Torok, new Chapter chairman; Assistant Secretary of the Army Frank H. Higgins, guest of honor; Judge T. Wilkes Thrasher, of the Hamilton County Court; and Maj. Gen. F. A. Hansen, Assistant Chief of Army Ordnance for Field Service. A record crowd of nearly 400 members and guests was present.

Mr. Skelly, as outgoing chairman of the Chapter, passed the gavel to the incoming chairman, H. F. Torok, of the Ross-Meehan Foundries. Mr. Torok then introduced the other Chapter officials including E. J. McFadden, vice-chairman and head of the Membership Committee; Admiral Richardson, program chairman; William B. Bunn, secretary-treasurer; and the following committee members: E. E. Cline, Sr., Ernest Holmes Company; Mr. Skelly of the Wheland Company; E. M. Jones, Tennessee Copper Company; S. C. Smith, Wheland Company; and Durwood Williams, Industrial Committee of 100.

Admiral Richardson then called on Gordon P. Street, president of the Wheland Company, to introduce the guest of honor. Mr. Higgins presented a most interesting address, taking as his theme "The business side of the Army." Noting the strength of Russia, which our defense program must consider, he stated that the Soviets have a combined total of 325 divisions, 500 submarines, 20,000 modern jet aircraft, and 35,000 tanks built since World War II. He also noted the growing strength of Red China, stating that its gross national product is now equal to that of Japan.

In explaining how the defense dollar is spent in this country, Mr. Higgins pointed out that of the $5.3 billion in procurement expenditures by the Army between July 1957 and July 1958, 35 per cent went to small business, and he noted that there were still many opportunities for small business to participate in Army contracts.

The distinguished guests, in addition to those already mentioned, were: Brig. Gen. J. M. Colby, Deputy Commander, Army Missile Command; Sam Parry, general manager, Combustion Engineering Corporation; James L. Payne, vice-president in charge of sales, Ross-Meehan Foundries; Ernest Holmes, Jr., president, Ernest Holmes Company; Col. Thurston T. Paul, Deputy Commander, Army Ballistic Missile Agency; Col. Henry S. Newhall, Commandant, U. S. Army Ordnance Guided Missile School, Redstone Arsenal; Col. G. H. Lang, Ordnance Officer, Third Army; Lieut. Col. Robert W. Darymple, Office of the Assistant Secretary of the Army—Logistics; Mayor R. B. Searcy, Huntsville, Ala.; M. F. Rankin, manager, Chrysler Missile Operations, Redstone Arsenal; Dr. W. M. Mebane, general manager, Redstone Division, Thiokol Chemical Corporation;

Joseph W. Wiggins, Thiokol Chemical Corporation, Redstone, Ala.; J. D. Darwin, secretary-treasurer, Tennessee Valley Post, A.O.A.; and Col. H. P. Dunlap, Commissioner of Fire and Police Departments, Chatanooga.

The next morning the Wheland Company was host at a breakfast for Mr. Higgins and his official party before their departure on an inspection tour of Fort Knox, Ky. The breakfast, held at the Patten Hotel, concluded a memorable event.

General Hinrichs Is Honored Guest And Speaker At Chicago Post Meeting

Maj. Gen. John H. Hinrichs, Chief of Army Ordnance, was the honored guest and principal speaker at the annual meeting of the Chicago Post of the Association on Tuesday, January 13th. More than five hundred representatives of the services and industry from the Chicago area were present. The meeting, held at the Palmer House, Chicago, was opened by W. G. Swartchild, Jr., president of the Post.

A luncheon, sponsored by the Post, was held at the Chicago Club at noon on the 13th honoring participants of the Army Ordnance Corps Executive Development Program. Companies presently participating in the program are: International Harvester Company, Inland Steel Company, Motorola, Inc., Borg-Warner Corporation, Pullman-Standard Car Manufacturing Company, Stewart-Warner Corporation, General American Transportation, Sears, Roebuck & Company, and Armour Research Foundation.

An afternoon technical session was held at the Palmer House. This session covered in layman's language the development, production, and fielding of missiles, satellites and outer space vehicles. Dr. G. G. Quarles, chief scientist at the Army Ordnance Missile Command at Redstone Arsenal, discussed "Science and Space." R. W. Cuthill, chief engineer at the Army Ordnance Missile Command, covered "Industrial Participation." Col. Charles G. Patterson, Assistant Chief of Staff for Military Applications and Training at the Missile Command, discussed "Military Application of Missiles."

Also on display at the Palmer House for the benefit of all members was the first showing in Chicago of the Ordnance Standardization Exhibit which covers the spectrum of modern Army weaponry from the newest missiles to tanks and personnel carriers.

At the dinner meeting, Colonel Swartchild called on Col. Leo A. Codd, executive vice-president of the A.O.A., to present a scroll to Col. John Slezak, Chairman, Reserve Forces Policy Board, Department of Defense, on behalf of the Association in appreciation of faithful service to the national defense of our country.

Colonel Slezak then took over as toastmaster to introduce the distinguished guests and the guest speaker.

In his remarks the colonel reminded his listeners of the achievements of the Association between the First and Second World Wars. "The substantial number of men who, through the A.O.A. activities, kept their interest in the development, design, and production of ordnance materiel alive, made a tremendous contribution during the early days of World War II," he said. "And, since World War II, A.O.A.'s growth and effectiveness in the service of our military establishment has been most outstanding. Indeed it has become a mighty and useful arm to those charged with the responsibility for the defense of our country."

General Hinrichs in his address praised the excellent support that Army Ordnance has received from industry in the Chicago area. He enumerated the major tasks of the Ordnance Corps and pointed out the mutual interest of citizens and ordnancemen in forging superior weapons so that the Nation always will be prepared to fight for its heritage—individual freedom.

Guests at the head table were: Capt. Roy R. Marken, Chaplain, Ninth Naval District; G. D. Dearlove, Post vice-president; Col. C. L. P. Medinnis, Commanding Officer, Chicago Ordnance District; Brig. Gen. H. F. Bigelow, Chief of Manpower, Office, Chief of Army Ordnance; Brig. Gen. George W. White, Commanding General, Ordnance Training Command; Maj. Gen. R. G. Butler, Commanding Officer, Army Ordnance Special Weapons-Ammunition Command; and Dr. Quarles.

Also Rear Adm. E. P. Forrestel, Commandant, Ninth Naval District; Brig. Gen. F. J. McMorrow, Chief, Industrial Division, Office, Chief of Army Ordnance; M. J. Allen; Brig. Gen. W. Ghormley, Commanding Officer, Army Ordnance Weapons Command; Colonel Patterson; Mr. Cuthill; E. J. O'Keefe, Post executive vice-president.

The following Post directors also were present: Keith Parsons, William Caples, H. J. Prebensen, Charles Z. Meyer, Glen Lloyd, H. O. Bercher, Z. C. R. Hansen, and Frank Parker.

At Chicago Post meeting were, left to right: Col. C. L. P. Medinnis, commanding officer, Chicago Army Ordnance District; Maj. Gen. John H. Hinrichs, Chief of Ordnance, guest of honor; and W. G. Swartchild, Jr., Post president.

Captain Bassler Receives H. W. Alden Award At Ordnance School Graduation

Capt. Robert E. Bassler was the recipient of the Herbert W. Alden Award in virtue of his selection as outstanding graduate of the Ordnance Officer Advanced Course at the Aberdeen Proving Ground Ordnance School. Captain Bassler was commissioned in the Army upon being graduated from the U. S. Military Academy in 1946.

The award was presented at the graduation exercises of the class on December 10th by Col. Leo A. Codd, executive vice-president of the A.O.A. Maj. Gen. J. H. Hinrichs, Chief of Army Ordnance, delivered the graduating address after an introduction by Col. A. M. Smith, II, School Commandant. (Contd. on p. 772)

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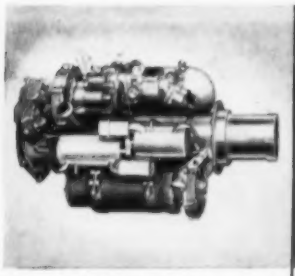

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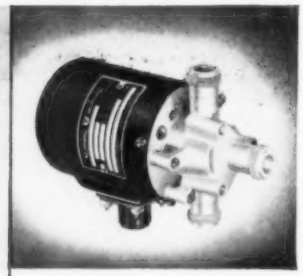

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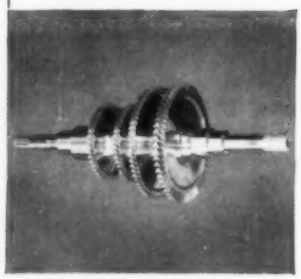
These are some of the products of the TAPCO Group of Thompson Ramo Wooldridge Inc. With $150,000,000 of high-efficiency production facilities, TAPCO is one of the nation's leaders in the development and manufacture of mechanical systems, equipment, and components that must meet stringent performance specifications under extreme conditions of temperature, corrosion, and stress.

Through its metallurgical and chemical laboratories, TAPCO continually extends its capabilities in the technology of high-temperature alloys, powder metallurgy, cermets, ceramics, and other materials. TAPCO was one of the principal pioneers in the fabrication of titanium, and is currently engaged, in cooperation with E. I. du Pont de Nemours & Co., in the development of manufacturing techniques to handle niobium and its alloys.

In product design and development, TAPCO's 500-man engineering team is experienced in a wide range of specialties, including hydraulics, aerodynamics, electronics, pneumatics, thermodynamics, and nucleonics.

Aircraft and missile technology increasingly demands mechanical systems, equipment, and components that can meet uncommon requirements of precision, strength, and reliability under the most severe environmental conditions. The combination of engineering, metallurgical and manufacturing competence represented in the $160,000,000 per year activities of the TAPCO Group provides an integrated capability of unusual effectiveness for the design and manufacture of such products.



Four-stage turbine wheel

100,000 rpm turbine-driven alternator

Missile gyro ground test unit

Jet engine case assembly

Thompson Ramo Wooldridge Inc.

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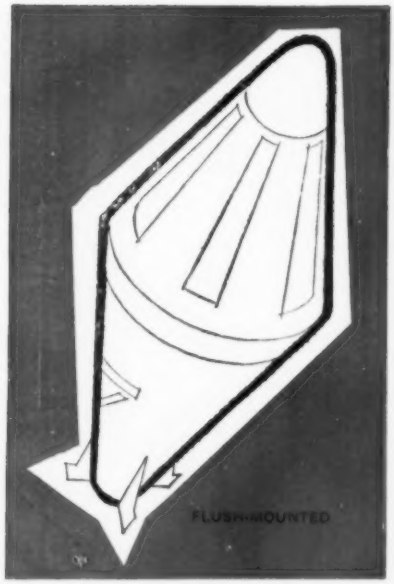

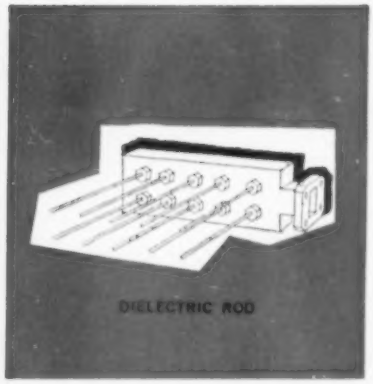

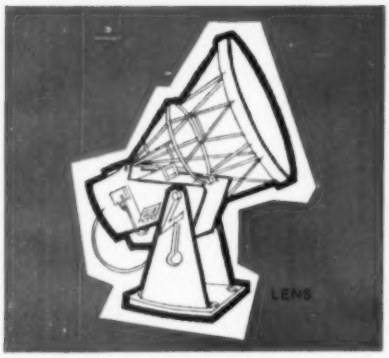

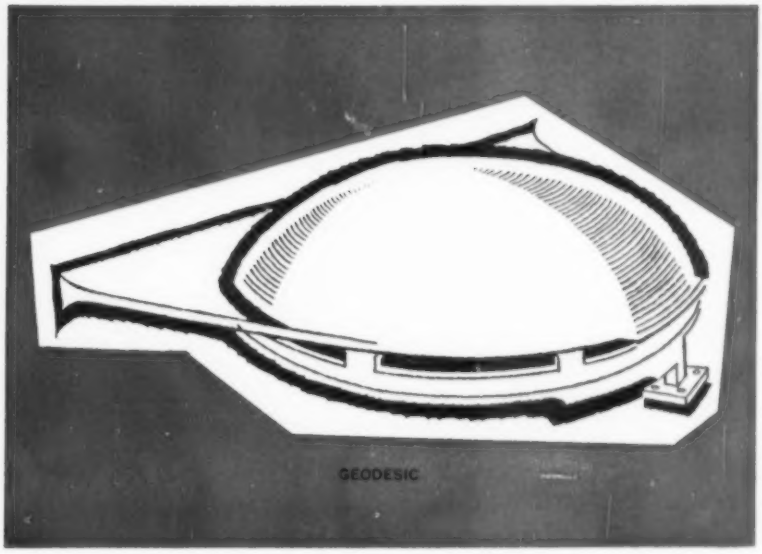

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Among distinguished guests who witnessed the ceremony were: Maj. Gen. H. N. Toftoy, Commanding General, Aberdeen Proving Ground, and Brig. Gen. G. W. White, Commanding the Ordnance Training Command.

The Alden Award, a check for $100, was founded by the Timken-Detroit Axle Company, a division of Rockwell Spring and Axle Company, to honor Col. Herbert W. Alden, Ordnance Reserve Corps. Colonel Alden was chief engineer of Timken and for years maintained a close interest in ordnance engineering problems and performed many outstanding services for Army Ordnance.

J. L. Ashby Is Elected President Of San Francisco Post At Board Meeting

Jack L. Ashby, vice-president and general manager of Kaiser Steel Corporation, is the newly installed president of the 1,100-member San Francisco Post of the American Ordnance Association. He was elected at a Post board of directors' luncheon on December 16th at the Pacific Union Club in San Francisco when the outgoing president, William E. Waste, of Bechtel Corporation, was host.

Newly elected San Francisco Post President Jack L. Ashby, left, is congratulated by Dean Witter, right, A.O.A. vice-president, as E. Finley Carter, newly installed first vice-president, and Col. John M. Stark, reelected Post secretary-treasurer look on. Officers were elected at a meeting of the Post's directors (Army photo).

Other newly elected officers are: E. Finley Carter, director of Stanford Research Institute, first vice-president; L. Eugene Root, general manager of Lockheed Missile Systems Division, second vice-president; Col. John M. Stark, commanding officer of the San Francisco Ordnance District, reelected secretary-treasurer. Lawrence S. Fletcher, Oakland attorney, reelected national Council representative.

Leslie B. Worthington, president of the Columbia-Geneva Division of U. S. Steel Corporation, was elected to the board of directors to replace B. C. Heacock whose term expired December 31st. Reelected as directors for a 3-year term were Mr. Ashby, Mr. Root, and Elmer R. Peterson, vice-president of Standard Oil Company of California.

Dean Witter, regional vice-president of the American Ordnance Association and former Post president, attended the luncheon and congratulated the new officers.

Washington Post Members Turn Out In Large Numbers To Attend Two Meetings

Members of the Washington Post turned out in large numbers to honor Rear Adm. P. D. Stroop, Chief of the Navy Bureau of Ordnance, on Thursday, December 18th. Stewart L. Magee, first vice-president, presided at this monthly luncheon meeting held in the ballroom of the Willard Hotel, Washington, D. C.

Admiral Stroop paid tribute to nearly a century of cooperation between Army and Navy Ordnance in the maintenance of the Nation's defense. He then elaborated on features of the philosophy of managing naval ordnance.

At the head table were: Vice Adm. E. W. Clexton, Chief of Naval Material, and his deputy, Rear Adm. R. L. Swart; W. H. Moore, special assistant for procurement to the Assistant Secretary of the Navy, Material. From the Navy Bureau of Ordnance there were Rear Adm. John Quinn, Deputy Chief; Rear Adm. T. A. Ahroon, Assistant Chief for Planning; Rear Adm. W. F. Raborn, Director of Special Projects; Capt. E. A. Ruckner, Assistant Chief for Research and Development; and Capt. H. N. Larsen, Assistant Chief for Material.

From Air Force Headquarters were Maj. Gen. A. H. Luehman, Chief of Information, and Max Golden, Deputy Assistant Secretary for Material. Also at the head table were Col. R. E. Peters, representing the Chief of Army Ordnance; Col. H. R. Thayer, Office, Deputy Chief of Staff, Logistics, U. S. Army; M. C. Richmond, Washington Post vice-president; and Henry R. Long, Post secretary-treasurer.

The Washington Post scored another noteworthy success on January 15th when Robert F. Brady, chief, Communications Branch, Research and Development Division, Signal Corps, spoke on the instrumentation in the Atlas satellite.

Post President Ernest A. Tupper presided at the luncheon in the Hotel Willard's grand ballroom and welcomed the gathering of over two hundred members and guests. He then introduced the following head table guests: Col. C. W. Clark, Chief, Ordnance Research and Development Division, Office, Chief of Army Ordnance; Rear Adm. Rawson Bennett, Chief of Naval Research; Brig. Gen. J. B. Bestic, Deputy Director, Communications-Electronics, Air Force Headquarters; Brig. Gen. Albert F. Cassevant, Commanding General, Fort Monmouth, N. J.; Rear Adm. J. S. Dorsey, Deputy Director, Communications-Electronics, Joint Chiefs of Staff; Brig. Gen. H. F. Bigelow, Chief, Office of Manpower, Office of the Chief of Army Ordnance; John R. O'Brien, president, Armed Forces Communications-Electronics Association; M. C. Richmond and Stewart L. Magee, Post vice-presidents.

Mr. Brady described the many months of experimentation and preparation required to perfect Score—Signal Communications by Orbiting Relay Equipment. He also gave a brief account of the part played by industry and other agencies engaged in the project.

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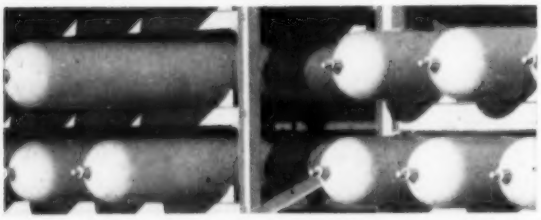

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ARMAMENT IN REVIEW

New Polaris Submarine

The Electric Boat Division of General Dynamics Corporation, Groton, Conn., has been assigned construction of the lead ship of a new class of fleet ballistic missile submarines. This prototype ship is one of four additional Polaris submarines for which funds were approved by the Eighty-fifth Congress. Secretary Gates pointed out that advance design and procurement of long-lead-time components of this newest class of SSB(N) submarine have been in progress for some time.

Five other fleet ballistic missile submarines already are under construction. These are the GEORGE WASHINGTON (SSB(N)-598), the PATRICK HENRY (SSB(N)-599), the THEODORE ROOSEVELT (SSB(N)-600), the ROBERT E. LEE (SSB(N)-601), and the ABRAHAM LINCOLN (SSB(N)-602).

Missile Measurement Ship

A completely refurbished missile measurement ship, the S. S. AMERICAN MARINER, was inspected recently by 150 military and civilian scientists in Baltimore, prior to its departure for duty in the South Atlantic.

Sponsored by the Advanced Research Projects Agency, Department of Defense, and the Army Ordnance Missile Command, Huntsville, Ala., the ship is outfitted with the most advanced radar and other electronic and optical apparatus needed in tracking and checking the performance of experimental ballistic missiles during their trajectories after firings from the Atlantic Missile Range at Cape Canaveral, Fla.

Equipment aboard the new vessel was installed by the Radio Corporation of America, Moorestown, N. J., and is expected to provide the most precise data yet collected at sea to complement ground-station missile measurements at missile test range points.

Fifty-two civilian scientists, engineers, and technicians, in addition to the crew, will make up the ship's complement for each tracking mission. Many will be employees of RCA. Other technical personnel, under separate contract with Barnes Engineering Company, Stamford, Conn., will operate special measuring equipment other than radar on board the ship.

The scientific staff will make precision observations and collect data on the characteristics of a missile's performance from its ascent to remote altitudes in space, through all levels of the earth's atmosphere, to the final plunge to earth or sea. Data obtained by the staff aboard the missile measurement ship will be shared by all branches of the Armed Forces.

Mobile Message Center

Development of a new highly mobile, air-transportable communications center, designed to direct fast-moving U. S. Army forces, was announced recently by the Department of the Army. The system, which has an extremely high degree of mobility, can be set down almost anywhere by helicopters and be flown out immediately for relocation elsewhere. It also can be moved rapidly from place to place on conventional Army trucks.

Developed by the U. S. Army Signal Corps, it provides the vital nucleus for a communications network of radio, telephone, telegraph, and teletypewriter combat links. The system can be carried by helicopter to a remote destination in hours rather than days, or can be set up on otherwise inaccessible mountaintops. With its communications tentacles spread over hundreds of miles, the new system can get an urgent message through to a distant outpost even with direct lines broken or destroyed.

Speed and flexibility in communications would be vital on a battlefield where troops would have to be continuously on the move and widely dispersed to avoid annihilation by a nuclear warhead.

For quick transportation and added versatility, the center is made up of separate aluminum houses or "shelters," each fully equipped and independent. These can be hooked up quickly to fit any battle situation. Small centers for the front lines would have two or three shelters; larger headquarters would have as many as twenty-four. Each shelter carries its own independent supply of electricity, but also can plug into a central power source.

High-priority combat messages flowing into the center from combat groups and other sources would be immediately available to the Army field commander. And the same network of communications lines carries his message with reflex speed to higher headquarters or to hard-hitting Army combat elements.

The new system, the first fully air-transportable message center of its kind, is the result of twelve years of design and research. It was developed under the guidance of the U. S. Army Signal Research and Development Laboratory, Fort Monmouth, N. J.

Redstone Unit

Men of B Battery of the Army's 209th Artillery Group successfully completed the firing phase of their training recently by launching their weapon, the Redstone missile, under tactical conditions at White Sands Missile Range, N. Mex. The fully tested liquid-propelled 200-mile-range ballistic missile, now tactically deployed in the hands of NATO forces in Europe, was fired at less than its full range.

Redstone Project of Ordnance Mission's Systems Test division at White Sands instrumented the missile's flight to provide engineering user evaluation data in the program.

The first tactical firings of the missile by troops were by the 40th Field Artillery Group at Cape Canaveral, Fla., and White Sands Missile Range in the spring of 1958. The three tactical firings of the Redstone missile all have been successful. Two were by the 40th Field Artillery Group and the third by the 209th.

The men of B Battery of the 209th assembled, erected, and serviced the missile prior to firing.

Hydraulic Tank Cleaner

At the Lenape Ordnance Modification Center, Newark, Del., hydraulic-jet type cleaning equipment speeds the preparation of tank and part surfaces prior to painting. The cleaning units, made by Sellers Injector Corporation, produce a high-velocity, hot jet stream of water mixed with detergent to clean entire tank exteriors or larger parts—such as gasoline tanks, ammunition racks, or other components to be painted.

The center, operated by Chrysler Cor-

(Continued on p. 777)

Hydraulic and Mechanical

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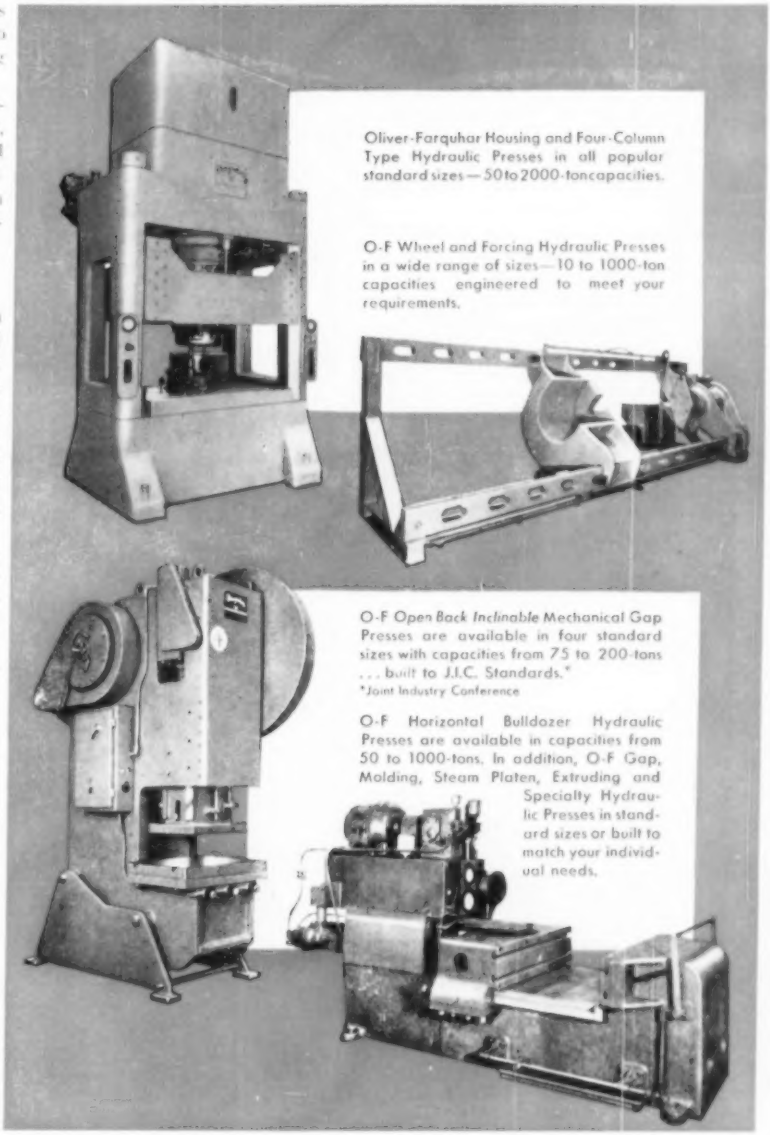
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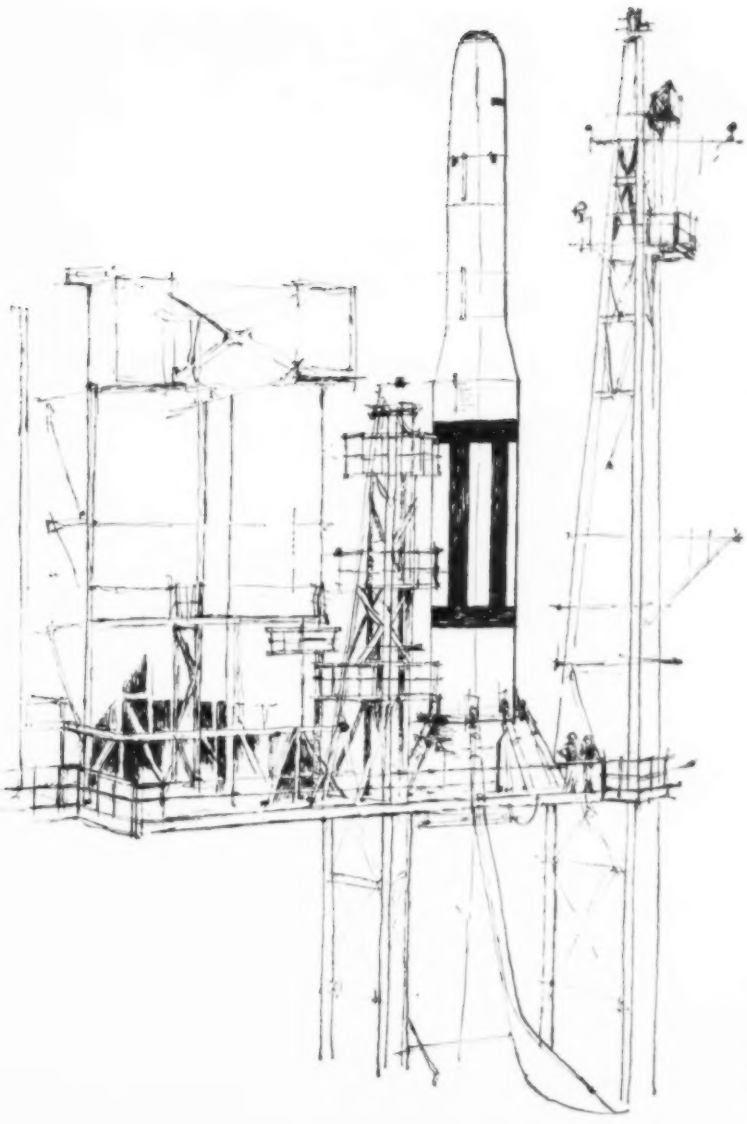

poration for the U. S. Army Ordnance District, Philadelphia, produces the latest model of the Patton 48 medium tank. It also modifies previous models which have been shipped back from Army proving grounds or stored in lots at this modification center. Dirt and grease can accumulate from a variety of sources, including road tests, hard use at proving grounds, and simply dust in the air during storage.

New Medical Packet

U. S. Army Medical Service supply officers recently demonstrated to representatives of the Office of the Assistant Secretary of Defense (Health and Medical), the Navy's Bureau of Medicine and Surgery, and the Air Force Surgeon General a jointly devised emergency medical packet for use in a mass casualty situation.

Such situations occur whenever the number of persons injured is out of proportion to the medical resources available. The problems of mass casualty care are thus not confined to nuclear warfare but can result from fires, floods, hurricanes, and other civil disasters.

The new medical packet, called Phase I Emergency Medical Treatment Unit, is designed to meet conditions immediately following a military disaster. It has been assumed that during this period no direct professional medical help may be expected, and casualties will either treat themselves or be cared for by other nonmedical personnel. Containing 23 items, the emergency packet will provide medical material for treatment of approximately 100 casualties for about 72 hours.

This packet is, however, designed for much more than first aid. The items included have been carefully selected, and training in their use will be carried out by all three services. Packaged as one unit, the emergency packet has nine component cartons: two master packs containing a synthetic plasma expander, surgical instruments and other items, one fracture pack, two burn packs, and four wound packs.

Supersonic Interceptor

An Army Hawk air defense missile scored a direct hit recently on a 1,400-mile-an-hour target missile 6 miles above White Sands Missile Range, N. Mex. The intercept left only debris of the Hawk's target. Nike Hercules also has scored a direct kill with a warhead against the XQ-5, a target missile, but a reduced explosive charge was used in that mission and the target was recovered for further use.

Designed primarily to combat low-flying aircraft, Hawk demonstrated its upper-altitude capabilities in the test.

(*Continued on p. 779*)

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Typical of the systems designed and developed by Magnetic Amplifiers, Inc. is the Advanced Missile Checkout Equipment shown in the illustration. The equipment is an alignment and final checkout instrument which performs complete static gains and dynamic responses on the MACE AUTOPILOT with an accuracy of better than ±.2%. Over 200 separate tests are performed in sequence.

The success of this equipment for missile equipment checkout, is due to its inherent reliability, human engineering, functional flexibility, and simplicity of operation with no maintenance.

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Working with Raytheon Manufacturing Company, Waltham, Mass., on Hawk is Northrop Aircraft of Hawthorne, Calif., as subcontractor and Aerojet General as engine manufacturer.

Metal Aircraft "Sandwich"

A new kind of sandwich, said to be capable of withstanding as much as 2,000 degrees Fahrenheit while under severe pressure, has been developed to beat the heat barrier for space ships and jets traveling nine times the speed of sound. The sandwich, developed by Republic Aviation Corporation, is constructed of high-temperature-resistant metals like stainless steel and Inconel X and is basically a layer of corrugated metal "filler" with a flat "bread" sheet on either side.

It is believed that aircraft flying at Mach 9 at 100,000 feet could become a reality in 5 years with development of proper structural materials and power plants to handle such speeds. Corrugation is believed to be part of the answer. Temperatures at Mach 9 would reach 2,000 degrees in 10 to 15 seconds from aerodynamic heating, and ordinary structures capable of withstanding such temperatures would be so heavy and bulky as to be impractical, whereas the corrugated sandwich gives vital heat resistance at light enough weight for aircraft use.

Actually, corrugated structures have been used by engineers for years. The difficulty with sandwiches of this type for aircraft has been basically a manufacturing problem. It was impossible to get strong welds and close enough tolerances to meet the precise demands of modern-day aircraft missiles, and space vehicles.

Instead of using adhesives, which melt at comparatively low temperatures, the company uses electrical resistance welding to fuse the pieces together. Results are accurate to three-thousandths of an inch on the thickness of the sandwich. Sheets as large as sixteen square feet have been fabricated. In addition to their lightness, the corrugated panels are as much as seventy-five per cent cheaper than earlier types of sandwich construction which use a honeycomb filler instead of corrugated.

Weather Radar System

A new ground weather radar system that enables TV stations to televise approaching storms as far away as 150 miles has been developed by the Radio Corporation of America.

Through the use of a standard RCA studio vidicon film camera, the radar scope presentation of a storm may be transmitted to the television station's viewers, with the radar "picture" superimposed on a map of the area for orientation.

The system was specially designed for television broadcasting operations, in which station personnel can learn quickly to identify storm types and make weather evaluations. The nature, size, and other characteristics of a storm can be determined. Even the extent of rainfall can be estimated.

The new radar system can be of value also in agricultural operations, at airports, in construction projects, harbor activities, off-shore oil drilling and a variety of other applications.

The system's transmitter sends a high-power, rapidly-pulsed signal to a disk-shaped antenna, which rotates 360 degrees at fifteen revolutions per minute within its protective housing, capped by a plexiglass radome. When the signal encounters a storm or other weather target, some of the transmitted energy is reflected back to the system's receiver. The electronic circuit measures the length of time for the signal to make the round trip, and the data are pictorially displayed on the indicator screen in contour form, showing the storm core and areas of heaviest rainfall.

The control console provides switching for viewing weather conditions within any one of three ranges—0-20 miles, 0-50 miles and 0-150 miles. As a storm moves closer, the shorter ranges are used.

Transistor Tester

The first transistor tester capable of checking the performance of transistors while they are connected within their circuits, is now being produced by Philco Corporation. A contract to build more than 900 transistor testers has been awarded to Philco's Government and Industrial Division by the Navy Bureau of Ships.

Under a previous Navy contract, Philco design engineers developed a unique combination of transistor circuits which resulted in this technical break-through—an in-circuit transistor tester. In-circuit transistor testing saves trouble shooting and servicing time without turning on power in the equipment.

'Copter Landing System

W. L. Maxson Corporation, New York, N. Y., has announced the receipt of a contract from the Bell Helicopter Corporation, Fort Worth, Tex., for the development of a helicopter landing system. Known as the Help (helicopter electronic landing path) system, it is for use in take-off and landing of helicopters during zero visibility conditions.

(*Continued on p. 781*)

There's a fast, safe, low-cost way to put clear, durable marks on your ordnance item or package—and your Markem field engineer can give you full facts. He knows which Markem machine, printing element and specialty ink or marking compound will do the most efficient marking job for you—depending on the size and shape to be marked, rate needed, conditions the marking must withstand. Dozens of standard direct, offset and screen process machines . . . new Unitized Printing Heads to combine with other equipment . . . special purpose machines . . . explosion-proof equipment . . . quick-change type for short runs . . . thousands of specialty inks and marking compounds including MIL spec types — are readily available for your needs. Get *experienced* help—call your local Markem man. Markem Machine Co., Keene 9, N. H.

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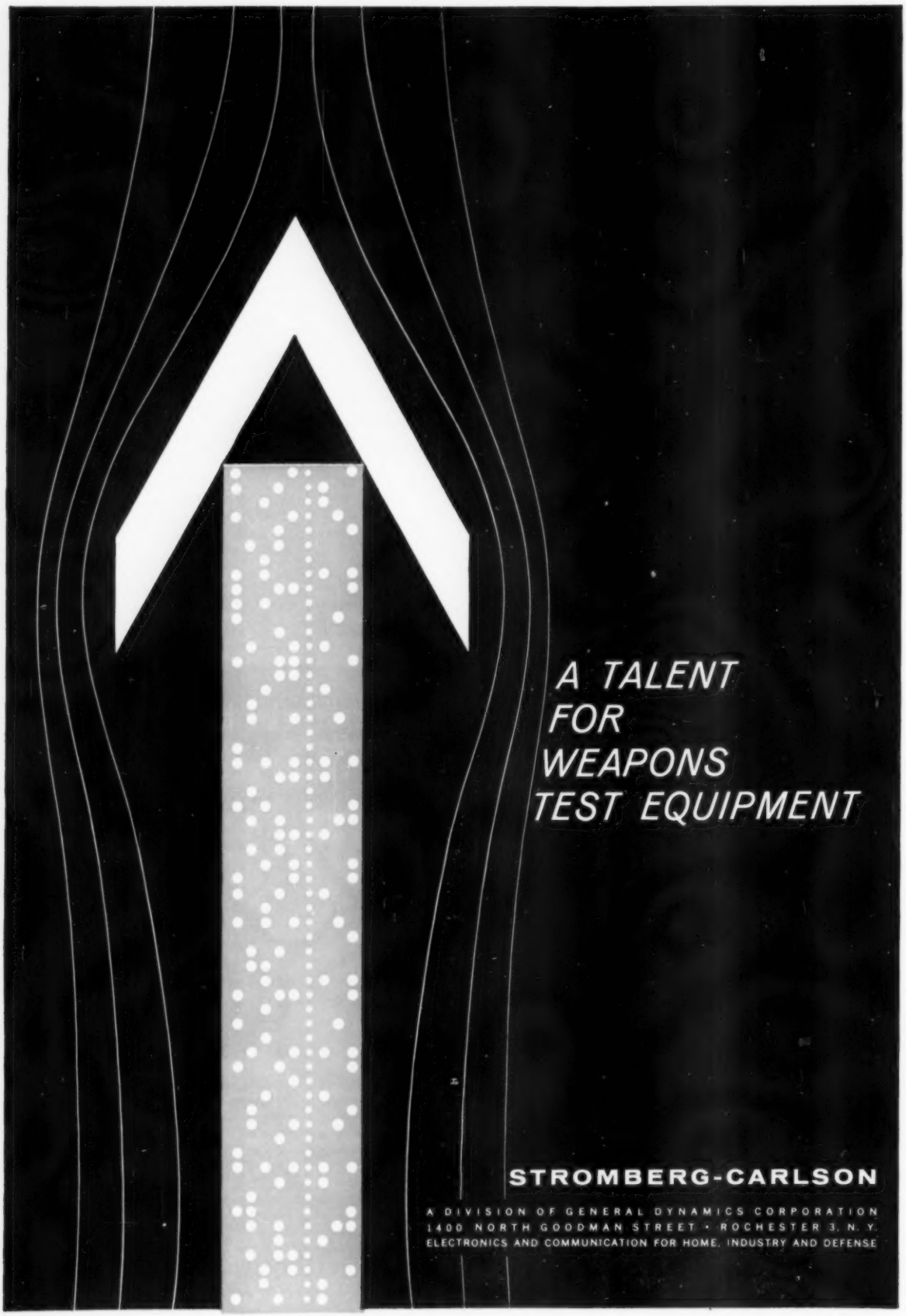
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SCATE—Stromberg-Carlson Automatic Test Equipment—embodies existing hardware as a nucleus.

Implementation with special stimulus generators and response monitors rounds out the SCATE system, which meets the testing needs of any weapons system, component, or sub-assembly . . .

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The Help system is part of the over-all MW-Rails (microwave remote area instrument landing system) being developed by Bell Helicopter Corporation for the Signal Corps and Office of Naval Research.

Electron-Beam Furnace

An electron-beam furnace has been used successfully on both pilot and plant scale to melt, refine, and cast such special metals as titanium, zirconium, tungsten, tantalum, molybdenum, beryllium, and columbium. The metals so processed are extraordinarily pure and, as a consequence, often have unique physical properties. For example, ductile columbium, which was previously only a laboratory curiosity, has been made in commercial quantities by electron beam furnacing.

The furnace utilizes electron bombardment in a high vacuum to melt chemically active materials with high melting points. Techniques have been developed which make possible the volatilization and removal of certain critical impurities from the processed metals. This results in end-product metals which are of unique purity and have properties not attainable by any other method.

The process is based primarily on high-vacuum techniques. Heat to melt the metal charge is supplied by an electron gun which serves as the cathode and bombards the melt stock (the anode) with electrons. The molten metal drops into a water-cooled crucible. The heat required to maintain a pool in the crucible is also provided by electron bombardment. The surface of the molten pool is kept at a constant level as the solidified ingot is withdrawn downward.

The process differs in principle from arc melting not only in the heating mechanism (high-voltage electron bombardment rather than an electric arc) but also in the level of vacuum used. The electron-beam furnace vacuum is .01 to 0.1 microns; arc furnace vacuums usually range from 10 to 100 microns.

Under conditions existing in the electron-beam furnace, carbon, hydrogen, and oxygen generally are removed rapidly as carbon monoxide, metal oxides, or similar gaseous compounds. As a rule, impurities which form compounds which have a vapor pressure of at least 10^{-4} atmospheres at the surface of the melt are removed easily.

Electron-beam melting probably will find its greatest use in the purification of refractory materials and high-melting metals such as columbium, tantalum, tungsten, beryllium, vanadium, molybdenum, and special stainless-steel alloys. The immediate significance of the process is twofold:

1. Because the process will make available, for the first time, commercial quantities of high-purity materials at substantially lower cost, electron-beam melting is expected to stimulate development of many newer metals.

2. In many cases, the process permits the recycling of scrap. Such recycling is particularly significant in view of the relatively high cost of many of these metals.

Electron-beam melting has several important advantages over arc melting. For example, electron-beam operations can be stopped and started at any time whereas arc melting cannot. In the latter process a valuable ingot may be lost if it becomes necessary to halt the melting process. Also, the molten metal can be maintained in superheated conditions for periods of time which may be varied at will. Moreover, the electron-beam furnace can melt material in any form—ingot, powder, flake, or sponge; the arc process requires compacted material.

Electron-beam melting also can be used for zone refining. In some respects it may prove superior to present zone-refining processes. A major attribute of electron-beam melting is that there is no apparent limitation to the diameter of the bar or ingot that can be processed—as has been the case with highly reactive metals processed by conventional zone-refining operations. Consequently, electron-beam-melted materials can be processed faster and cheaper.

The economic factor is not the only one which is attracting the attention of industrial firms and government agencies. Metals, such as tantalum and molybdenum, have been produced which are of far higher purity than has ever been accomplished previously. Too, ductile columbium, hitherto only a laboratory curiosity made by solid-state sintering, is now produced as 4-inch-diameter ingots in commercial quantities by electron-beam furnacing.

Mace Being Readied

The U. S. Air Force's 587th Tactical Missile Group at Sembach Air Base, Germany, will be converted from the TM-61C Matador to the TM-76A Mace early this spring. (See photograph on page 742.)

Personnel trained in the employment of the Mace will be deployed from the Tactical Air Command to USAFE during the period April through July 1959 to replace personnel presently assigned to the group. The total number of personnel assigned to the group will not be affected by the conversion process. The new tactical missile will make a significant increase in the effectiveness of the United States contribution to NATO forces.

The Mace TM-76A is an improved version of the Matador, a jet-driven surface-to-surface tactical weapon. Both weapons are manufactured by the Martin Company, Baltimore, Md.

NEW DEVELOPMENTS

Self-Propelled Mortar

A recently developed Ordnance combat vehicle is the full-tracked, self-propelled amphibious 81-mm. mortar, T257. The new vehicle weighs 18,760 pounds and may be dropped from aircraft via parachute. It is 84⅝ inches high and has a ground clearance of 15 inches. It carries a commander, driver, and 4-man mortar crew at 40 miles an hour on land and 4 m.p.h. in water.

The tanklike hull of the T257 is built of lightweight metals and is similar to the T113 armored personnel carrier. It has 12-inch-wide tracks, torsion-bar suspension, and is powered by an air-cooled 208-horsepower Continental 4-cylinder opposed engine through an Allison XGT-90-1 transmission. It was developed under contract with Food Machinery and Chemical Corporation.

Film Guides Missile

Guided only by the unseen hand of radar from a system made for a missile, its position checked only by a never-before-used synthetic film of the terrain, a large twin-engined aircraft has successfully flown exactly prescribed courses covering hundreds of miles in an unusual demonstration of self-contained electronic guidance. The airplane was an Air Force C-47, the film came from a library maintained by the U.S.A.F., and the guidance was furnished by a standard production Atran unit built by Goodyear Aircraft Corporation for the TM-76A Mace weapon system.

The successful demonstration marked the first time a film had been taken "off the shelf" for use in a missile guidance system test of this nature. With a number of courses being "plotted" on film for the Air Force library, the demonstration conceivably could have taken place almost anywhere in the world.

The Atran guidance system is unique in that it can control missile maneuvers during flight, without ground or air control of any kind subsequent to launching the missile. Once airborne, an Atran-equipped missile or aircraft can ascend to clear a mountain range, descend to a few hundred feet over a coastal plain, or fly a winding course for hundreds of miles, completely independent of human control at all times since the programmed information needed to direct the missile or aircraft is stored on film inside the vehicle.

New ASW Aircraft

The Navy recently announced a $22.2 million follow-on production contract with Grumman Aircraft Engineering Corporation, Bethpage, N. Y., for S2F-3 Tracker aircraft. The S2F-3 is an improved version of the S2F-1 all-weather antisubmarine airplane which has been operational with the fleet since early 1954.

The most modern developments in antisubmarine warfare electronics and armament have been incorporated in the new airplane, and its fuselage has been lengthened to allow more space for its four crew members.

Meteorological Rocket

A revolutionary new low-cost meteorological rocket that can be launched by a 2-man crew is being produced for the Office of Naval Research by the Atlantic Research Corporation of Alexandria, Va. Named Arcas (all-purpose rocket for collecting atmospheric soundings), the rocket eventually will be made of fine spun-glass fibers so that it may be fired by meteorological personnel over populated areas and exploded to harmless fragments after it has gathered needed data.

Army photo

Firing crew members check Arcas rocket.

The Navy requested the U. S. Army Signal Missile Support Agency to test-fire the Arcas at White Sands Missile Range because of the Agency's previous successful experience in shooting such atmospheric-measuring vehicles as the Loki, Nike Cajun, and Aerobee Hawk. Arcas is 7 feet in length and 4½ inches in diameter. It weighs only 71 pounds, complete with a load of slow-burning solid fuel. One Arcas reached 174,000 feet with a payload of instrumentation.

A new type launcher of ingenious design makes it possible to fire the rocket with a crew of only two men. The launcher resembles a mortar tube, 11 feet long, than can be swung 360 degrees in azimuth and 20 degrees in elevation from the vertical. A breech at the base of the tube opens to permit easy loading of the Arcas. Burning time of the low-acceleration, slow-burning solid fuel is 25 seconds as it pushes the rocket to a velocity of 3,400 feet a second.

Cold-Cathode Tube

Development of a new, cool-running radio tube, considered the first major break-through in basic tube design in more than thirty years, has been developed jointly by the Army Signal Research and Development Laboratory, Fort Monmouth, N. J., and Tung-Sol Electric, Inc., Bloomfield, N. J. It glows blue instead of red and uses less than one-tenth the power of a standard hot-cathode tube.

The new "cold-cathode" tube could be the forerunner of a new line of general-purpose tubes for broad military and civilian use. Due to its potential reliability, the tube may outlast any equipment in which it is used. The cold-cathode principle is believed adaptable to almost all types of electron tubes, including TV screens, giant radar and transmitting tubes, as well as nearly all general-purpose radio tubes. Miniature and subminiature tubes, which would compare favorably with the transistor in size, also may be feasible.

In the new tube, the hot element is replaced by a cold cathode—a tiny nickel cylinder specially coated with porous magnesium oxide. Instead of heat, a high-voltage field causes the electron flow, which in turn produces the tube's characteristic phosphorescent blue glow.

High-Temperature Material

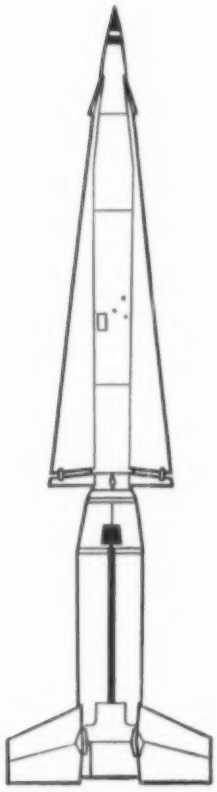
A material that can live through the searing blast of a 5,000-degree Fahrenheit rocket-engine exhaust, unchanged by heat

The man:

A U.S. Army missileman working with Nike Hercules missile equipment. The modern Army relies heavily on the special skills and knowledge of men like this who are trained extensively in military schools, and supported technically in the field by Army Ordnance Corps, Western Electric and Douglas field service men.

The mission:

Defense of U.S. cities. Army Nike Hercules units are already on duty at many key points...have the important assignment of guarding against enemy aircraft.



The missile:

Douglas-built Nike Hercules, product of a Douglas-Western Electric-Army Ordnance team, has successfully engaged supersonic drone targets at altitudes well over 60,000 feet. Other drone targets have been destroyed up to 100,000 feet, and at ranges beyond 75 miles.

Status . . . . . **Combat ready**
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shock or erosion, has been announced by Avco's Research and Advanced Development Division, Wilmington, Mass. Called Avcoite, the new material is a specially designed and highly developed reenforced ceramic that resists gas erosion at extreme temperatures and eliminates structural failure due to heat shock. It is claimed that negligible changes in rocket nozzle throats have resulted at temperatures of 5,000 degrees Fahrenheit for test durations of more than 60 seconds with actual rocket motors.

Mobile Air Support

Project Two-Wheels, a mobile communication system consisting of five compact, lightweight, trailer-type vans, recently completed operational field tests at Tinker Air Force Base, Okla.

Airlifts were performed by cargo aircraft and helicopters during tests conducted by the Air Research and Development Command (ARDC) and the Airways and Air Communications Service, a subunit of the Military Air Transport Service. The airfield communication-navigation system was developed by ARDC's Rome Air Development Center and Craig Systems, Inc., Lawrence, Mass.

Included in the facilities are an air traffic control unit, a radio receiving set, a radio transmitting set, a facsimile receiving set, and a finder set. A lightweight portable telescoping antenna mast also is a part of the system.

Drone Sets Record

An unofficial world altitude record for propeller-driven drone aircraft was set recently by an RP-77D U. S. Army aerial target when it climbed to an altitude of over 46,000 feet during Army evaluation of the craft at the Dona Ana Range, Fort Bliss, Tex.

The RP-77D radio-radar-controlled drone.

Report of the nearly 9-mile-high flight was made by Radioplane Division of Northrop Corporation which produces the RP-77D radio-radar-controlled drone for U. S. Army Ordnance. The flight was conducted by the U. S. Army Air Defense Board Surface-to-Air Service Test Section.

Rocket-launched, the RP-77D is turboprop-powered to speeds in excess of 400 miles an hour at above 40,000 feet and is capable of flight duration exceeding one hour at this altitude. It is a low-cost target, constructed almost entirely of fiberglass laminate and has an additional capability for photo and television combat surveillance missions.

All-Weather Navy Fighter

The Navy will have a new jet fighter in its arsenal in 1960—Chance Vought Aircraft's F8U-2N Crusader, a carrier-based, limited all-weather fighter aircraft which flies at nearly twice the speed of sound. Basically, the F8U-2N is a development of the F8U-2 with increased capability for detecting and destroying targets in darkness and inclement weather. To perform this mission, the Crusader has a number of significant improvements.

It has a Chance Vought-developed autopilot. Push-button-operated controls perform many of the pilot's routine tasks such as holding an altitude, holding a heading, selecting a new heading, or orbiting over a given point, allowing the pilot to concentrate on his mission. It also will have improved radar, revised interior and exterior lighting systems, and improved instrumentation as well as provision for utilizing Sidewinders and other missiles. *(Contd. on p. 786)*

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Powerplant will be the Pratt & Whitney J-57 P-20 engine which will give the new all-weather aircraft an even higher speed during combat than the F8U-2.

New Sparrow III Missile

The Navy's newest air-to-air missile, the Sparrow III, has been installed as defensive armament on carrier-based jet interceptors operating with the Seventh Fleet in the Western Pacific and greatly strengthens the fleet's defensive capability against aerial attack.

Developed and produced by Raytheon Manufacturing Company, this new electronically controlled missile can be fired

McDonnell F3H-2 interceptor armed with Sparrow III missiles.

with greater aiming leeway because in flight it acts for itself and has the ability to track down and destroy its target. The slender supersonic weapon delivers a warhead with at least fifty per cent more explosive force than previous comparable U. S. air-to-air guided missiles.

Sparrow III weighs 350 pounds, is 12 feet long and 8 inches in diameter. Although similar in outward appearance to an earlier Sparrow model, the new weapon's more advanced guidance system and unique radar technique provide a number of combat advantages. The missile has a longer range than its predecessor, and the pilot can fire at the target without even seeing it as a light on the radar scope tells him when the target is within missile range. He also can set the missile to fire at the target automatically when within range.

Giant Machine Tool

A new giant machine tool can form a one-inch-thick piece of stainless steel or other hard metal into an aircraft or missile part with no more apparent effort than a housewife uses to form a pie plate from her thin kitchen foil. In forming the metal part, the machine increases the strength of the material used up to 100 per cent.

Designed and developed by Siegler Corporation's Hufford Division, the unit will shape parts heretofore considered impossible or impractical to manufacture in one piece. In operation, the machine cuts the production cycle by more than fifty per cent over the method now used for making such items as rocket-engine cases.

Known as the "spin forge," the machine is capable of applying a total work force in excess of 1,000,000 pounds to form parts up to 60 inches in diameter and 10 feet in height. The tool is 25 feet wide, 24 feet high, including its base, and weighs more than 450,000 pounds.

In operation, the metal to be formed is placed on the spin forge's mandrel, a form that is shaped as the desired part, and held tightly in place by a vertical tailstock or hydraulic ram that can exert 200,000 pounds of force. The mandrel is then rotated at speeds up to 400 r.p.m., and 2 massive working rollers, set across from each other at either side of the mandrel, come in to force the metal over and around the form. *(Continued on p. 789)*

THE CAPABILITY TO DESIGN AND DEVELOP THE MOST ADVANCED SOLID PROPELLANT PROPULSION SYSTEMS

ASTRODYNE

Astrodyne has the capability and experience to design, develop, and manufacture complete solid propellant rocket propulsion systems, extruded and cast propellants, rocket motors and boosters, and gas generator charges for auxiliary power units.

Astrodyne built this capability by bringing together in one productive group an elite corps of scientists, engineers, and technicians. Men with experience in research, design, and manufacture of superior solid propellants for JATO units, gas generator charges, and large boosters were teamed with others who had pioneered in the development of the largest rocket engines in use today.

This experienced team now is at work on the development of large-scale cast propellant motors, the design of advanced lightweight rocket hardware, and the formulation and testing of high-energy propellants with optimum physical properties for ballistic missile applications.

Inquiries are welcomed on all phases of the solid propellant field—from preliminary design to quantity production.

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From the arctic to the tropics... from jet altitudes to submarine depths... Motorola design engineers wear headgear matching the varied military applications of Motorola electronics. Working side-by-side with the Army, Navy and Air Force end user, these engineers provide technical assistance and, in return, gain first hand operational knowledge. The result—an understanding of user problems reflected in the design maturity of Motorola's military electronics systems.

And as for the many hats, those shown above have been worn on these representative programs: **A** *Integrated Battlefield Communication* **B** *Supersonic Rendezvous and Station Keeping* **C** *High-speed Tank Range Finder* **D** *Test Range Microwave Relay System* **E** *Ballistic Missile Radio Inertial Guidance System* **F** *Shipboard Surface-to-air Missile Guidance* **G** *Member, Army Scientific Advisory Panel* **H** *DEW Line Air Defense Radar* **I** *Strategic Bombing Radars* **J** *Amphibious Landing System* **K** *Shipboard Air Defense Data System* **L** *Tactical Drone Guidance.* For data on how Motorola's military experience can be applied to your problem... or for detailed information on engineering career opportunities... write to: Motorola, Inc., Military Electronics Division, Dept. A, 8201 East McDowell Road, Phoenix, Arizona.

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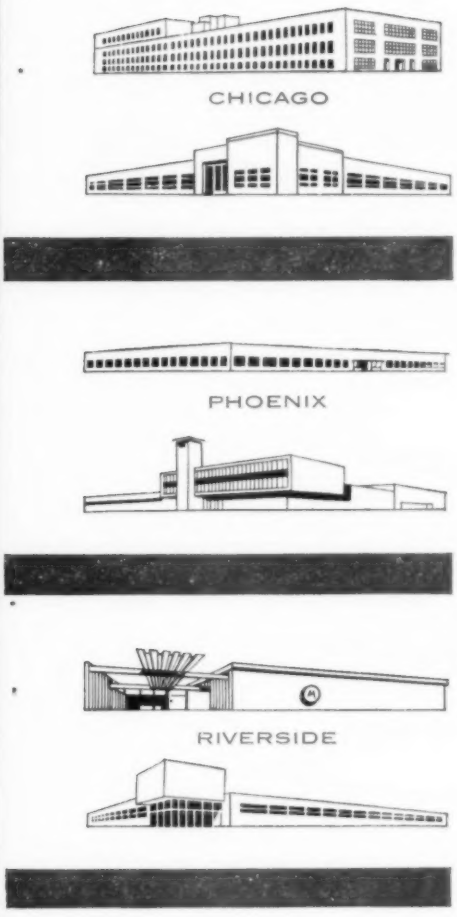

Working laboratories for Motorola engineers

Six Military Electronics Division plants in three locations... over 550,000 square feet of engineering and production space devoted exclusively to the design, development and manufacture of advanced military equipment.

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Atomic Blast Shelter

An underground shelter designed for protection against atomic weapons effects has been tested with conventional explosives under high-explosive blast conditions. Tests of a prototype at the Army Engineer Desert Test Station, Yuma, Ariz., indicated that the new shelter can withstand blast pressures up to 60 pounds per square inch. An exterior pressure loading of 30 psi was reduced to 4½ psi inside the shelter.

The shelter is formed of heavy corrugated steel plates bolted together in the shape of a parabolic arch. The crown height of seven feet affords ample headroom. Sixty-eight feet long and ten feet wide, the test unit was placed in an excavation eleven feet deep, and covered with four feet of soil. Entrance to the shelter is through two combined vertical and horizontal tubes, each three feet in diameter and thirty feet in over-all length, capped with a perforated blast cover and door. At ground surface, rocks are placed around the tubes to a depth of five feet to form a blast arrestor.

The air supply is drawn from the atmosphere through the perforated blast cover and rock bed into the entrance tubes through a number of small holes in the sides of the tubes. Hand-operated blowers are used to draw fresh air into the shelter and to force out vitiated air.

Advanced Terrier Missile

An advanced version of the Navy's Terrier guided missile will be produced by Convair Division of General Dynamics Corporation, Pomona, Calif. The new missile will incorporate better guidance features and substantial improvements in coverage over the present Terrier. It is intended for the same surface-to-air use as the now-operational version.

Under the present shipbuilding programs, the Terrier will become a major element in the Navy missile arsenal. Two FORRESTAL-class carriers, three guided-missile cruisers, one nuclear-powered guided-missile cruiser, nineteen guided-missile frigates, one nuclear-powered guided-missile frigate, and one nuclear-powered aircraft carrier are scheduled to have Terrier capability. The present Terrier is now in use on the guided-missile cruisers U.S.S. BOSTON (CAG 1) and U.S.S. CANBERRA (CAG 2), and the guided-missile destroyer U.S.S. GYATT (DDG 1).

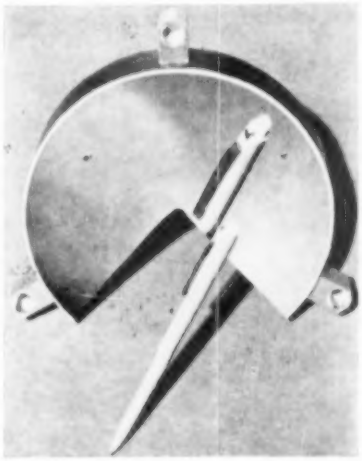
New Search Radar

A new search radar developed for the U. S. Navy by the Westinghouse Electric Corporation departs from previous radar designs in that it is crystal controlled, thereby achieving extremely high stability. Instead of the usual rectangular pulse, a shaped pulse has been designed to decrease the required bandwidth for operation, allowing the high-power system to work in crowded environments without interfering with other electronic devices. To simplify maintenance, the necessary testing equipment is built into the unit.

The control-monitor cabinet centralizes in one location the several important junctions of operating controls, condition indicators such as supervisory lamps, voltage and r-f power monitors, the noise figure monitor and monitor oscilloscope, and the trigger generating circuits.

Plastic Mirror

A major scientific development that reduces the mass-production cost of reflective optical components to a fraction of that entailed by older methods has been announced by the Singer Military Products Division. A negative that is cast from a precision ground-glass master mirror is used as a mold for casting positive replicas. Both negative and finished product are made of a special epoxy resin formulation. The reflective surface is an aluminum coating applied in high vacuum and overcoated with a protective film. The product, named the Repli-Kote mirror, faithfully duplicates the most intricate configuration, while its essential physical properties are said to be far superior to those of glass.



Mirror can be made in intricate shapes.

Dry Cell Resistance

The National Bureau of Standards has developed a nondestructive technique for measuring the true internal resistance of dry cells by applying a repetitive pulse. The technique has proved useful in determining how internal resistance changes as the cell is discharged under various standard test conditions or continuous or momentary current drain.

(Continued on p. 792)

COUNT DOWN!

for the conquest of space

IS THE ROCKET ENGINE MAN'S ONLY WAY TO OUTER SPACE?

Strapped and cushioned against the relentless grip of acceleration, a man lies supine and helpless as his crew of robot devices controls the upward drive of his ship. He watches the firing seconds tick away—300 . . . 150 . . . 600—until suddenly, both sound and acceleration stop simultaneously. In that second all weight ceases.

He is in Outer Space.

The only power that can put him there today is the large rocket engine. No matter how far and how fast space travel develops, these high-thrust engines provide one basic essential—the sheer brute force that can lift a payload from the surface of the planet to the airless void outside.

Endurance for vast distances

Once space is reached, a wealth of intriguing possibilities beckons. Entirely new aspects of propulsion are being developed to maneuver ships between the moving gravitational fields of Earth's neighbours in the solar system.

PACKHORSE OF SPACE. *Only means to put stores or people out beyond atmosphere is the big, high-thrust rocket.*

One advanced propulsion system that may be built soon is an ion rocket. This ultra-high-specific-impulse power plant provides low thrust for extended periods.

OUTWARD BOUND, *man's robot reporter heads off to a rendezvous with planet Mars.*

An endurance of months, or even years, is possible. Mounted in a suitable unmanned vehicle, such an interplanetary "private eye" would make the cislunar region seem like our own front yard. It could be sent off to reconnoiter the mysteries of Mars, Venus, or the Asteroid Belt.

Rockets ready today

To date, the vast bulk of successful missile and space projects in America have used Rocketdyne engines—Atlas and Thor for the Air Force, Jupiter and Redstone for the Army, the historic Explorer satellites, and the all-important first stage of the lunar probes. And Rocketdyne continues to improve the techniques of rocket engineering. High-energy fuels—storability—a full range of proven engine designs: these are some of the contributions Rocketdyne has made to weapon system operation for our nation's defense.

Million pounds of thrust

Rocketdyne is now at work on two approaches to propulsion systems that will deliver thrusts up to 1,500,000 pounds. One is a single-chambered engine, the other a grouping of engines adapted from the Thor-Jupiter engine family. From these will stem the multi-million-pound-thrust systems that are essential to launch the manned exploration of interplanetary Space.

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DRAWBAR HORSEPOWER—up to 180 from 155.

SIZE INCREASED—weight up approximately 4,400 lb. to 47,000 lbs., gauge widened to 84 inches.

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DRY-TYPE AIR CLEANER—removes 99.8% of dirt in intake air even under severe operating conditions.

GREATER STABILITY—with 5,505 square inches of track on ground.

BETTER VISIBILITY—new seat placement, location of console-type controls increases operator efficiency.

DEPENDABLE OIL CLUTCH—key retained feature for direct drive; practically eliminates clutch down time.

The new Caterpillar D8 Series H Tractor is ready *now* to increase its lead as undisputed king in its size class. A major achievement of Caterpillar's all-out research program, "Project Paydirt" (see box), the new D8 has been proved by a rigorous field testing program.

This D8 is new in design, appearance and performance. It is bigger, more powerful. It incorporates dramatic new engineering advances. It is easier to operate. And *more economical* to own.

Get the full story from your Caterpillar Dealer. Then *see* this great new machine at work on your job. You can't afford not to!

Caterpillar Tractor Co., Peoria, Illinois, U. S. A.

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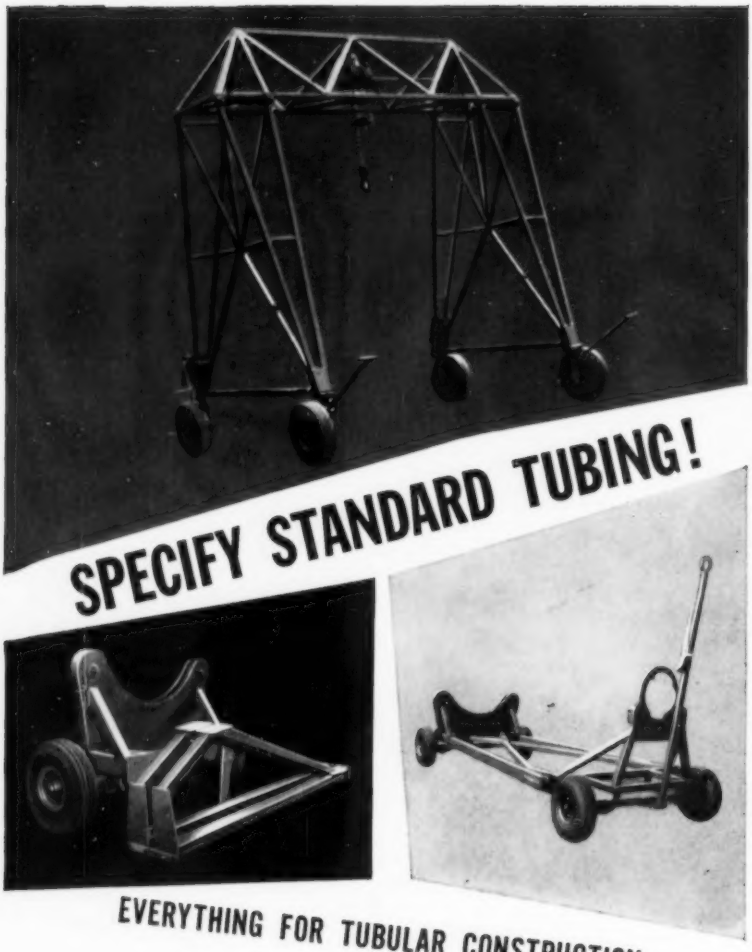

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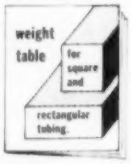

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a weight table for square and rectangular tubing. Write address below.

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New Developments (Contd.)

Results of such tests show that increase of internal resistance depends on the type of discharge, cell size, and variations in manufacture. The method was developed by R. J. Brodd of the Bureau's electrochemistry laboratory as part of a program to investigate the basic electrochemical reactions of dry cells.

Mechanized Information

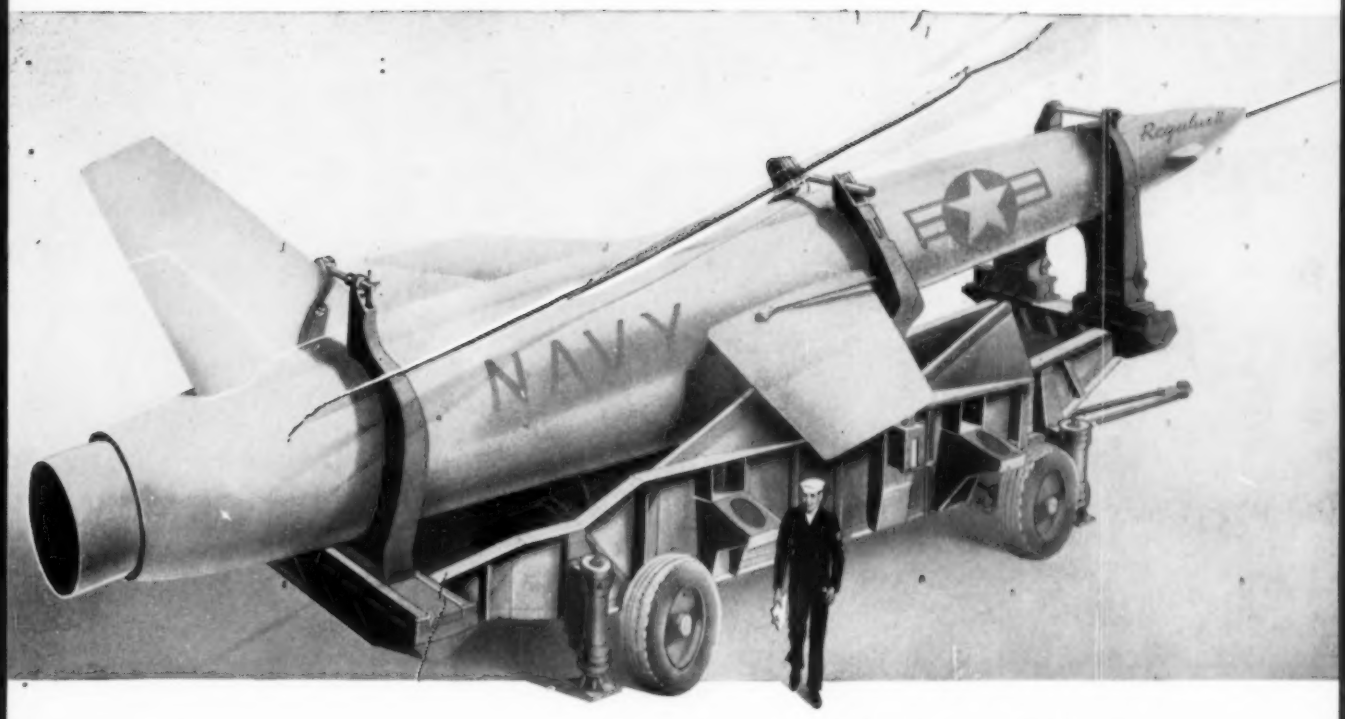
Military services and other defense agencies should get more for their money and quicker delivery of defense items through a newly perfected cost-reduction and time-saving system developed by the Westinghouse Electric Corporation. Known as

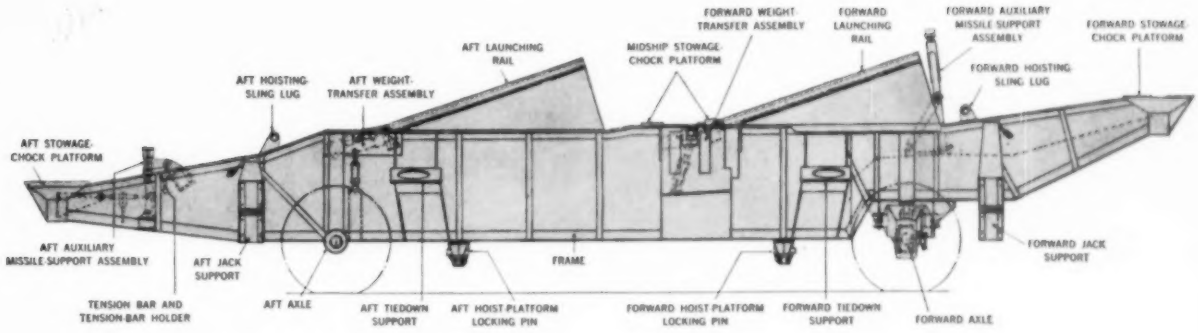
Stack of papers, right, used in production of Navy fire-control system, could be reduced to size at left with new method.

MMI (mechanized manufacturing information), the new technique utilizes especially designed semiautomatic and automatic business machines and will significantly compress the time element involved in getting new military developments from drawings into actual weapons.

The system is in full operation at the Air Arm Division near Baltimore, which produces electronic equipment such as terminal guidance systems for Bomarc area-defense missiles. MMI was developed by Air Arm engineers over a 2-year period for use in Westinghouse defense plants.

With this system, basic information is placed on perforated paper tape immediately after engineering drawings and specifications are issued. From this point on, data needed by each department are issued simultaneously on either tape or punched cards so that purchasing, for example, can begin to acquire materials while manufacturing is preparing to process these materials when they arrive. Four to ten weeks were required under the old system at the Air Arm Division to process manufacturing information, depending on the complexity of the product. Total elapsed time using MMI is fifty per cent less.





Another Loewy missile handling achievement—
"Dolly Launcher" for guided missiles on Navy cruisers

Designed and built by Loewy-Hydropress, this vehicle will stow, transport and launch guided missiles from Navy cruisers. As a handling vehicle, the "Dolly Launcher" will cradle and protect the missile against all shock loads imposed by the ship and during stowage and transfer to the launching-training hoist.

Loewy's competence in the design, construction and installation of ground and shipboard handling equipment for missiles of every size and type has been amply demonstrated. One example is its testing and flight-firing installation in connection with this country's participation in the International Geophysical Year. Another is its ship motion simulator for the "Polaris" missile which creates and duplicates the actual movements of a ship at sea. Today Loewy is designing a handling system for the "Terrier" missile to be used on aircraft carriers and the "Talos" warhead handling system for cruisers.

Long experience in machine design, hydraulics, electronics and automation enables Loewy-Hydropress to deal inventively and efficiently with the fast-changing problems of rocket and missile handling. Write Dept. H-3 for specific information.

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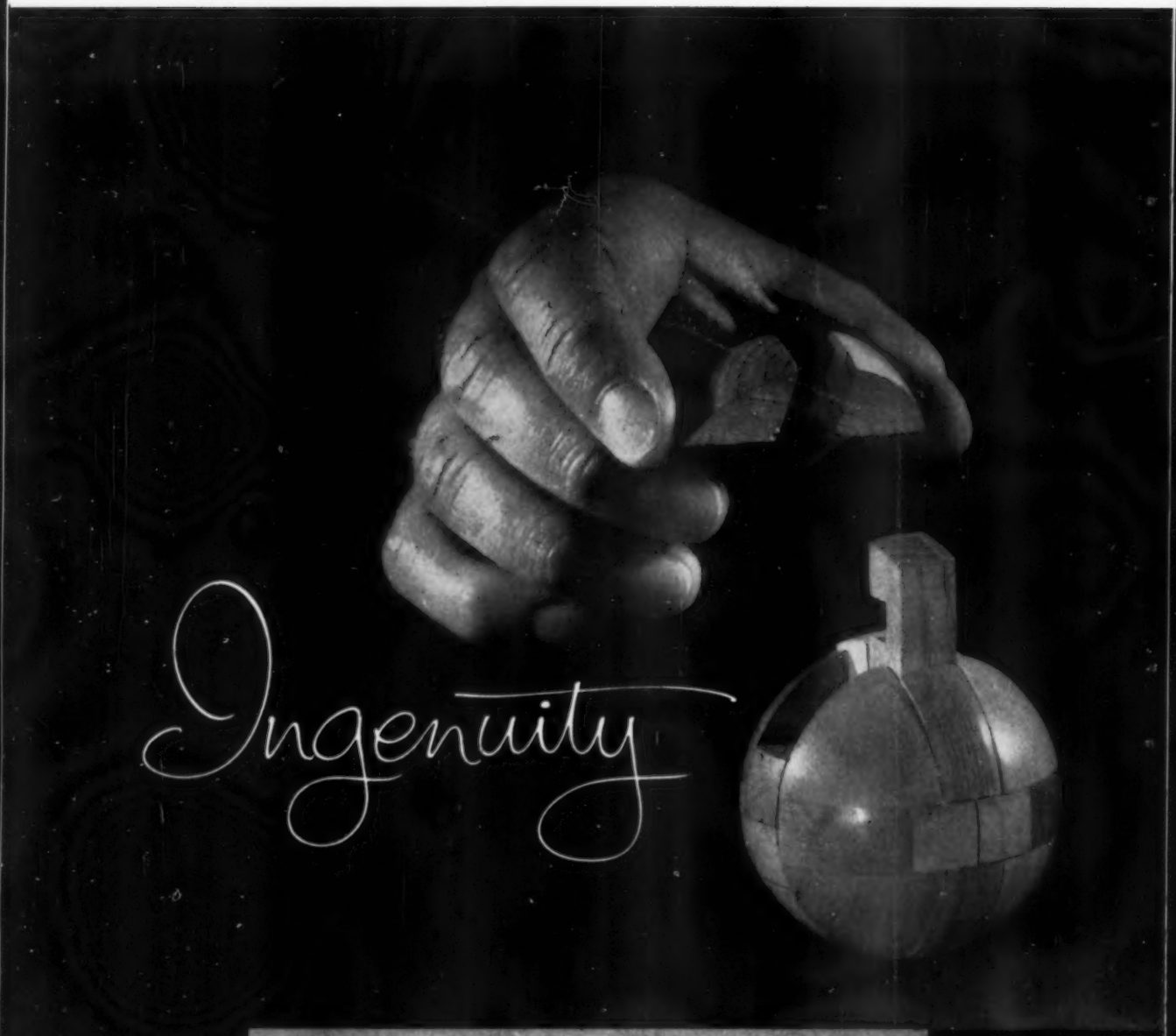

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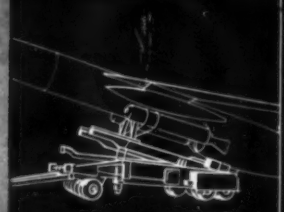

USAF's far-ranging *Snark* ICBM is ground-transported and launched by this rugged mobile launcher, produced by ACF for Northrop Aircraft, Incorporated, the prime contractor.

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MATERIALS PROGRESS

George S. Brady

Cooperation in Research.—Figures published on the amount of money which industry and government are putting into research, and that purport to show our leadership in science, vary greatly. The figure of $10 billion annually, given recently by a national business paper, is about average. But how well do these figures really indicate our progress in products and in the 92 elementary materials which, through research, make the innumerable materials from which products are made?

Tabulated statistics usually comprehend only research done on a budgeted basis, which is hardly an indication of total effort in a free society where much of the foundation of our industrial life was set by relative amateurs. Only the Government, the larger companies, and endowed universities are in a position to assign men to pure academic research, especially on modern atomic, electronic, or metallurgical projects where vast sums must be expended on equipment.

Perhaps conditions have changed since an ingenious druggist made the first matches by tipping splints of wood with sulphur, chlorate of potash, and sulphide of antimony, or Goodyear first vulcanized rubber on the kitchen stove, but basic thinking among free people has not changed.

In the final analysis of results there is no dividing line between development engineering and research. It might be difficult for the layman to probe the rare metals and discover that lutecium-176 gives off beta particles and gamma rays. But technicians and production men in the thousands of smaller plants that contract for the components of the big products are always "tinkering" with materials and products, and their findings are often notable discoveries[1] that may affect a whole industry. Many of these findings originate in complaints and suggestions from scientifically ignorant workmen dissatisfied with things as they are.

In a report made after World War II, the Institute of Cooperative Research of Johns Hopkins University stated: "During the years in which weapons are under development (by private industry, usually under contract), the military planners are not without information about them. And yet there has been in the past practically no effective translation of such information into economic readiness measures."

In that deduction perhaps lies the basic reason why Russia, in spite of its rigid system where freedom of suggestion is not likely to be on a plane with ours, can push forward so quickly. However secret our research projects may be, technicians and scientists are gregarious human beings, and they need the help that comes from discussion of the basic fundamental problems in the meetings and papers of their technical organizations.

It is notable that by the time a new product is ready for service trial and is labeled secret, the fundamental details are already widely known. There have been cases where men were refused permission to publish a description of a piece of equipment "for security reasons," although all the information came from scientific papers already published.

Undoubtedly, alert translators behind the Iron Curtain do get much of their advance scientific information from our scientific and trade papers, but this freedom of expression is characteristic of the universality of science that laid the foundations of progress through the nineteenth century, and it would only be injured by closer secrecy on the initial stages of research. The door that locks in an idea also locks out other ideas, and there is no such thing as secreting basic science.

Perhaps the fault that Johns Hopkins found in our lack of coordination a decade ago has been less apparent in the Soviet Union, and perhaps Soviet alertness has brought them that "effective translation . . . into economic readiness" of our basic discoveries more quickly than we have been able to achieve ourselves. If that is the case, what we need most is not more and more money going into research, but rather more and more cooperative effort to coordinate and translate the research results that we get.

The Useful Atom.—The possible uses of the results of atomic research are already far beyond the dreams of a decade ago. The Air Research and Development Command has been sponsoring a project for alloying by atomic bombardment. It is expected that alloys impossible to obtain by ordinary metallurgy can be obtained. A linear accelerator is used to insert microscopic particles of one metal into the crystal lattice structure of another metal. The alloying of iridium with aluminum to give high-temperature characteristics to the aluminum is one of the projects already undertaken.

Irradiation is being used to "graft" dissimilar plastics that cannot be joined otherwise. Battelle Memorial Institute has succeeded in thus coating synthetic fibers to eliminate static and to aid dyeing. Acrylic ester coatings on polyethylene prevent static, and styrene grafted to Teflon improves the adhesiveness of this nonsticky material.

In the chemical field, the applications of radiation are boundless. It has been found that atmospheric nitrogen for the production of acid can be fixed by nuclear radiation. Nitrogen oxides are produced by exposing compressed air at 150 pounds per square inch and a temperature of about 400 degrees Fahrenheit to radiation from the oxide of uranium 235.

Gamma rays from cobalt 60 will cause the reaction of sulphur dioxide and oxygen with liquid paraffins, and this radioactive material has been used as a catalyst for the sulphoxidation of paraffin oils to produce synthetic detergents.

In pharmaceutical work sutures of catgut now can be put in sealed tubes and bombarded by electron-beam radiation for sterilization. Previously, sterilization by heat required special handling and a long time period.

Welding Titanium.—Spot welding of titanium, which was considered almost impossible until recently, plus an advanced method of forming and stress-relieving in one press operation, made possible a composite panel structure that cut down weight from 2.3 pounds per square foot to 1.6 pounds per square foot in the F8U-3 Crusader III (*Chance Vought Aircraft, Inc.*), and made large savings in manufacturing costs.

The composite panel structure consists of a pure titanium beaded inner skin spot-welded to an 8Mn titanium alloy outer skin. Under heat and pressure, curved panels as large as 32 by 40 by 6 inches were press-formed, so that only 9 fixed and 4 removable panels were required for the complete aft-section skin. The beaded inner skin also made possible the elimination of angles and stiffeners.

Magnesium for Aircraft.—The new Canadian CF-105 Arrow fighter (*Avro*

Colonel Brady is a consulting engineer, author, and editor, Washington, D. C. He is a well-known authority in the field of materials, and his "Materials Handbook" is a recognized source of information on the subject.

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Materials Progress (Contd.)

Aircraft, Ltd.) with speeds above 1,000 miles an hour and an exceptionally high power-weight ratio, uses much magnesium for both the airframe and the engine, although many titanium parts are used to keep the power plant weight at a minimum. Magnesium castings in the engine weigh from less than a pound to 100 pounds. More than 500 pounds of magnesium are in the airframe, and machined HK31A magnesium-thorium plate is used on the underside of each delta wing. The 2- and 4-directional forming of the magnesium skins was done by vacuum forming in a autoclave.

Plastic Magnetic Tape.—*Du Pont* has solved the problem of getting as much as 2,400 feet of magnetic sound-recording tape on a 7-inch reel with a new Mylar 50T plastic which is amply strong with a thickness of only 0.0005-inch (conventional cellulose acetate tape is 0.0015-inch thick). The strong Mylar (terephthalic) film is oriented by stretching to give a maximum number of molecules in one direction, producing high strength lengthwise. The tape has a breaking strength of 120 ounces per ¼-inch of width.

New Aluminum Boat.—A new 53-foot, 16-foot beam, all-welded aluminum personnel boat of *Higgins, Inc.*, New Orleans, La., has a unique design with a polyhedral bottom. About 10 tons of aluminum-magnesium alloy 5456 was used in the construction. The frames were formed in the conventional curved shape, but a series of steps were cut into the outside edge of each frame and cold-formed plates fitted on and welded together.

Bottom and side plating is ¼- and 5/16-inch alloy, while the deck plating is ¼-inch aluminum. The boat has capacity for 30 passengers and a crew of 2, and can carry 2,000 gallons of fuel and 80 gallons of water. Cruising range is 550 miles at 40 miles an hour. With two 500-horsepower engines, the boat weighs, unloaded, 28,000 pounds.

Resin Application Methods.—A difficulty in using epoxy resins for encapsulation of electronic components on a production basis has been the necessity of mixing fresh batches at frequent intervals. Now, *Allied Chemical Corporation*, New York City, is offering hexahydro phthalic anhydride as a curing agent to give a pot life sufficiently long for an entire day's run on automatic machines.

For spraying applications, the short pot life of epoxy resins which required frequent costly mixing of new batches, has been overcome with a new spray of *A. Gusmer, Inc.*, Woodbridge, N. J. The spray gun mixes the catalyst in the proper proportion only at the instant of spraying.

Boats have been made with this process by the *Northwest Manufacturing Corporation*, Iron River, Wis., by spraying epoxy resin with chopped glass fiber through the orifice at 300 pounds per square inch into the boat mold. An epoxy gel is later sprayed on the outside to give a smooth exterior finish. It has made practical for the first time the production of boats from epoxies that give high strength-weight ratios and high resistance to sea water.

Oilless Bearing.—*Russell Manufacturing Company*, Middletown, Conn., has a new oilless plastic bearing which has been given a 200,000-mile simulated travel test in an automotive steering knuckle with no signs of wear or oxidation. The bearing consists of a synthetic and cotton fabric facing impregnated with *Union Carbide Corporation*'s BLS-2680 phenolic resin (a high-strength, heat-resistant grade) and set at a pressure of about 8 tons per square inch and a temperature of 340 degrees Fahrenheit to cure the resin and give it a tight bond to the metal housing. The bearing needs no lubrication and is offered for general machinery uses where temperatures do not exceed 350 degrees Fahrenheit.

Ultrafine Paint Pigments.—Reduced cost and faster production are obtainable with a new process of sand-milling ultrafine paint pigments developed by *E. I. du Pont de Nemours & Company*. The pigment is dispersed in a slurry with 20- to 30-mesh Ottawa sand. Continuous operation in a vertical mill is obtained by feeding the slurry in at the bottom and overflowing the pigment slurry at the top, retaining the sand on a screen at the top.

Chromium Ores.—After some years of research and trials, prospects now look good for the economic utilization of our abundant resources of low-grade chromium ores. The electroreduction plant of the *American Chrome Company* in Montana is currently producing regular tonnages of chromium concentrate with a low sulphur and phosphorus content as well as low cost for the ferrochrome. Successful commercial production of ferrochrome for steel-making from these ores could make unnecessary the large stockpiles of imported metallurgical-grade chromite.

Flexible Wire Harness.—A wire harness containing up to eighty 600-watt wires, designed by the *Polymer Corporation*, is not only compact and flexible but also eliminates the softening of insulation when soldering the wires. The essence of the system is the thin-walled Teflon spaghetti tubing for the wire covering.

For centuries angles have been read directly ...Now they can be read photoelectrically and the information transmitted in digital form.

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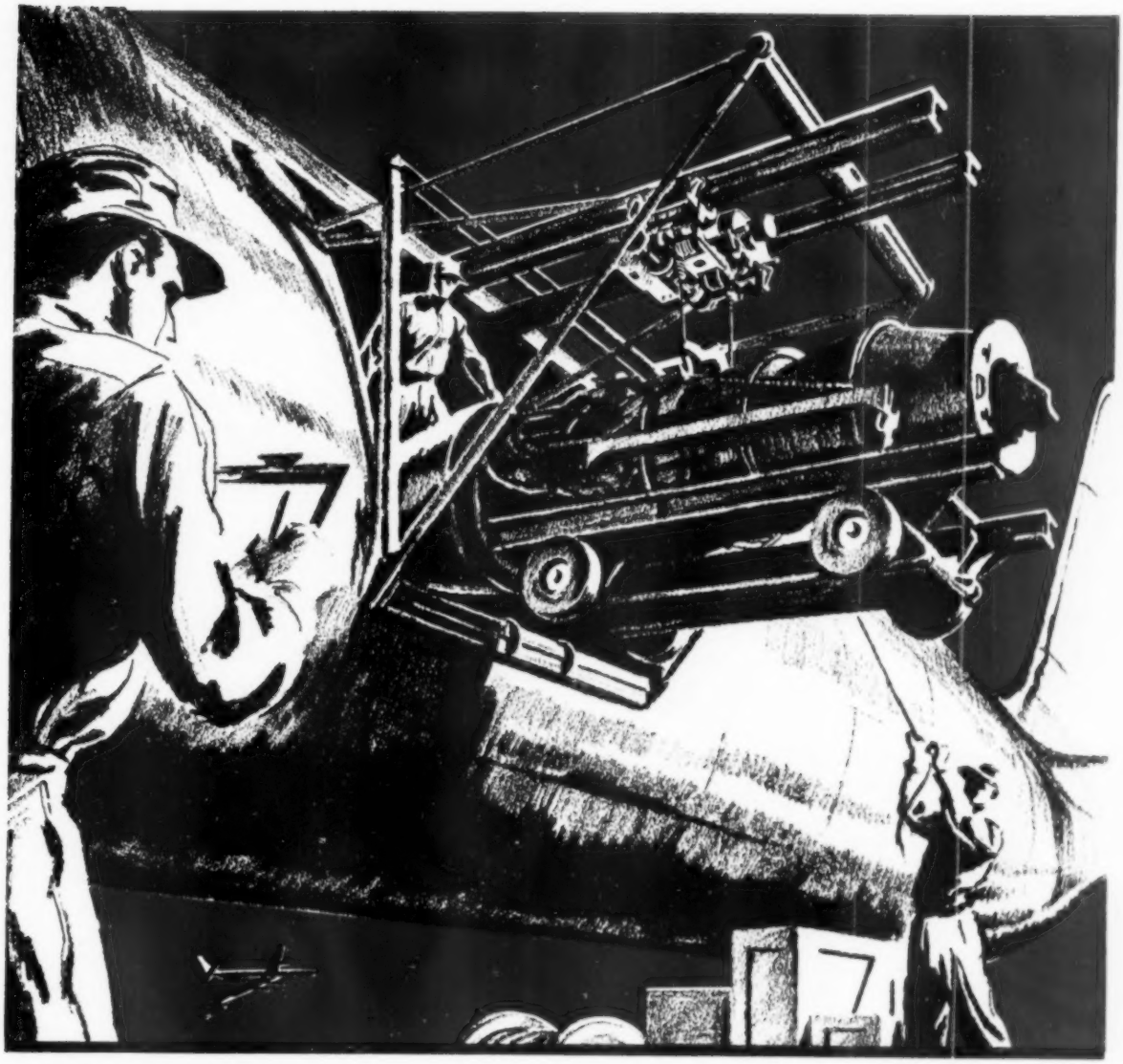
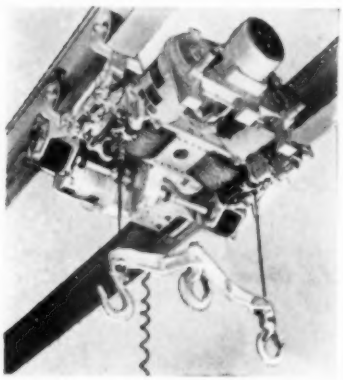
Write for Bulletin 8600–0



HIGH SPEED HANDLING

FLY-AWAY HOIST SPEEDS JET TRANSPORT



This compact, powerful fly-away hoist for the KC-135 lifts an 8,000 lb. load at 10 or 20 fpm . . . moves it in the plane at 20 or 40 fpm.

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Materials Progress (Contd.)

This plastic has a dielectric strength of 1,250 volts per mil, which permits wall thickness of only 0.008- to 0.020-inch. The cable, with 80 wires, is only ¾-inch in diameter and has high flexibility.

Synthetic Quartz Crystals.—For a long time the *Bell Laboratories*, Murray Hill, N. J., have had stand-by equipment for the production of synthetic quartz crystals. This readiness to go into production has had the effect of stabilizing natural quartz prices and improving quality standards. Bell technicians now have improved the processes so that large perfect crystals superior to the average run of natural crystals can be made readily at lower cost than the natural imported product.

Large Ceramic Shapes.—Very large and strong ceramic shapes have been produced by *Horizons, Inc.*, Cleveland, Ohio, by a system of winding glass filaments coated with a ceramic colloid and firing at about 1,000 degrees Fahrenheit. Commercial glass fibers that will withstand a temperature of 1,200 degrees are used. The ceramic bonding agent gives a higher heat-resistant temperature to the structure so that it may be used for continuous temperatures to 1,200 degrees. Missile bodies and large radomes are typical applications visualized for the products. The specific gravity runs from 1.5 to 2.2, the flexural strength from 10,000 to 23,000 pounds per square inch, and the dielectric strength is 450 volts per mil.

Aluminum for Reactors.—Aluminum, with its relatively low neutron cross-section and its ready availability as a structural material, makes a desirable metal for cladding in nuclear reactors, but it has been found to lose strength rapidly in contact with the high-pressure hot water at temperatures above 400 degrees Fahrenheit.

Working with Argonne technicians, *Aluminum Company of America* researchers found that under these conditions the metal picks up hydrogen, causing a weakening by the deep penetration of a mixture of metal and oxide, and that small amounts of nickel would hinder the process. A new aluminum alloy, X-8001, developed to withstand the hot-water corrosion, is essentially aluminum 1100 with the addition of from 0.9 to 1.3 per cent of nickel.

New Synthetic Rubber.—A new nitrile-silicone rubber developed by the *General Electric Company* retains the silicone characteristics of low-temperature flexibility and good strength at temperatures above 500 degrees Fahrenheit, but it does not swell with oils and solvents like the ordinary silicones. It is not just a mixture but is a long-chain polymer.

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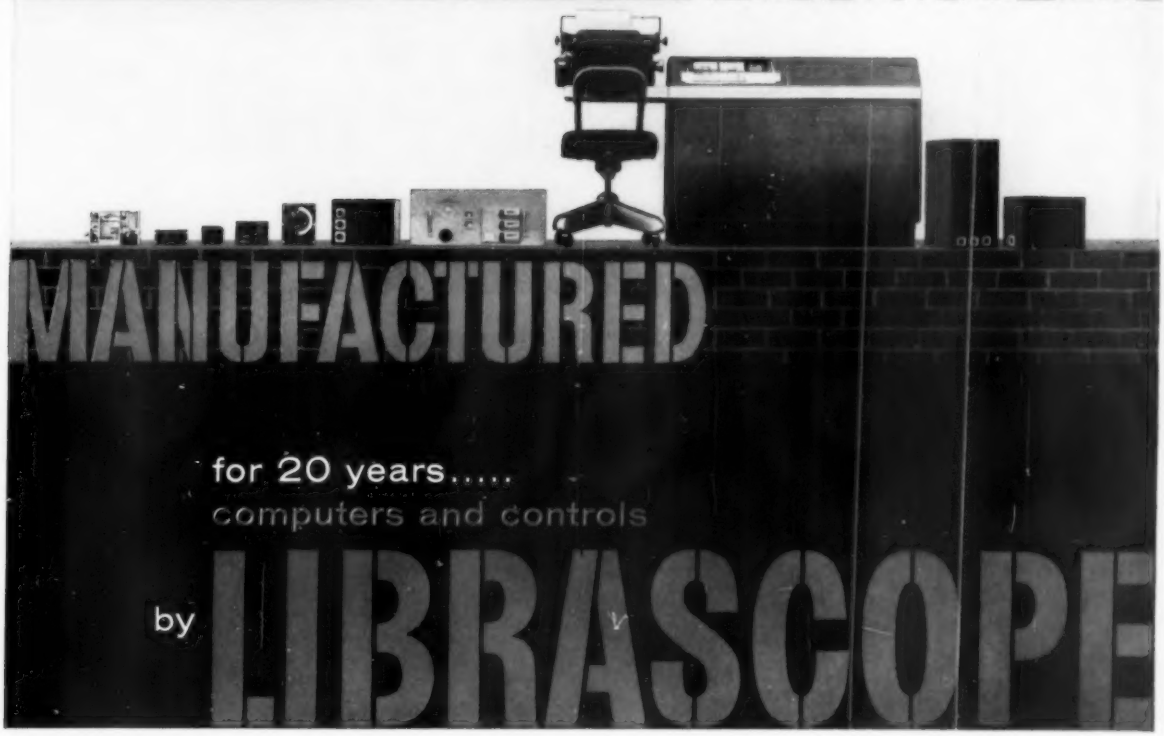

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all purpose power line

(20 to 1650 H.P. in only 3 cylinder sizes)

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Weight of the unit is kept to a minimum (only 5,800 pounds) through extensive use of aluminum in both engine and generator components.

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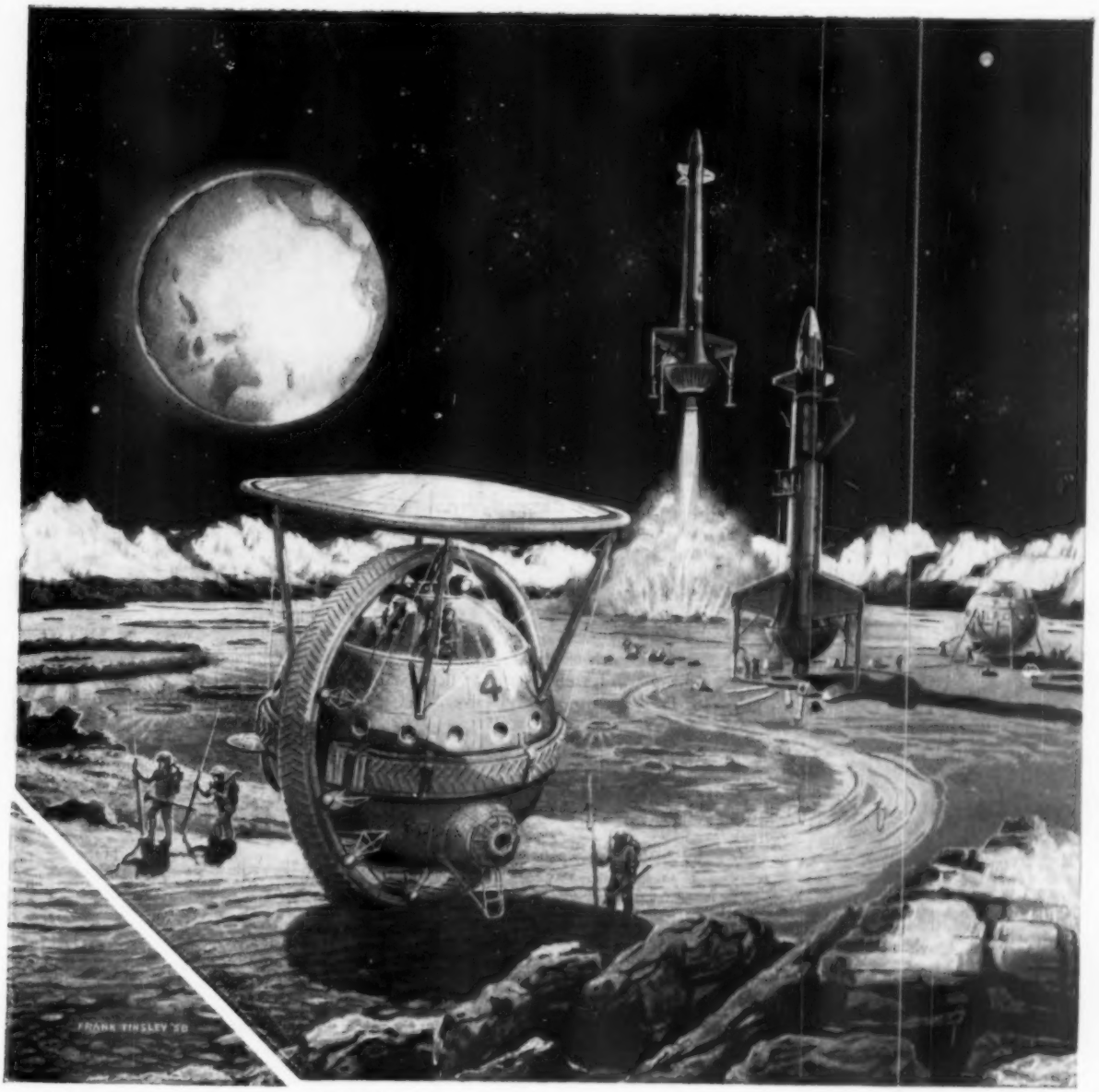

STEPS IN THE RACE TO OUTER SPACE

Lunar Unicycle

This 30-foot high Unicycle is designed for preliminary exploration of the Moon, once a base camp has been established. It's entirely constructed of inflated, rubberized fabric, with the exception of strengthening members, hatches and a few other items of equipment. Gyros stabilize and steer the vehicle; electric motors furnish the driving power.

Electricity for the motors and instrumentation comes from solar batteries mounted in the "parasol". The cleated, rotating wheel upon which the Unicycle travels is made of inflated tubes. A spare wheel, carried around the body, acts as a bumper in traversing narrow defiles. Built in two sections, these wheels are assembled by belt-lacing type fasteners.

The upper level, the navigating and communications deck, is ringed with recording and surveying instruments. Living quarters make up a middle deck and below is the hold with supplies, spacesuits, oxygen equipment and spare apparatus.

In the background, two of the expedition's ferry ships are seen; one landing, one unloading in the bright Earthlight.

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AMERICAN BOSCH ARMA CORPORATION

ROCKETS AND GUIDED MISSILES

Alfred J. Zaehringer

Astronautics.—The successful orbiting of the Atlas 10-B missile scored several technical achievements for the United States. First was the fact that the entire empty missile—8,750 pounds—was placed into orbit. Along with this dead weight of the rocket was included a payload of 168 pounds, considerably heavier than either Explorer or Vanguard satellites. The Air Force launching from Cape Canaveral, Florida, placed this country on a par with Sputnik I's payload of 189 pounds.

Unlike either Explorer or Vanguard, however, Atlas 10-B did not use multiple rocket staging. Atlas missiles are termed "stage and a half." Two booster rocket engines (165,000 pounds' thrust each) and one sustainer engine (60,000 pounds' thrust) burn simultaneously on launch from common propellant tanks. At a predetermined altitude, the booster engines are jettisoned and burning continues on the sustainer.

Atlas normally weighs about 244,000 pounds on take-off, but Atlas 10-B was stripped of excess weight and carried instruments in place of a warhead. In addition, a richer fuel mixture and about thirteen seconds of extra propellant burning time were provided.

Second important achievement of Atlas 10-B was the fact that the guidance was provided by a ground computer-guidance system to ensure accuracy. Thus the Air Force was able to achieve a successful launching and a stable orbit on the first shot. Atlas circles the earth on an orbit that is about 115 miles from the earth at its closest point and some 928 miles at its extreme point. Orbit travel time for the satellite is about 100 minutes.

Third achievement of the Atlas 10-B was its proof of the feasibility of using an orbiting satellite as a worldwide communications link or relay station. Called "Project Score" (signal communications by orbiting relay equipment), the satellite relayed a peaceful Christmas message from President Eisenhower. Life of the satellite was estimated at twenty to forty days.

Mr. Zaehringer, president of the American Rocket Company, Wyandotte, Mich., is a recognized authority on astronautics, guided missiles, and jet propulsion.

The National Aeronautics and Space Administration is now in the planning stage for the establishment of manned satellites. First test satellites will be unmanned and may use solid-propellant test vehicles. The eventual personnel capsule probably will be mated to an Atlas D booster rocket plus other stages, probably solid rockets, for additional boost, orientation, and retro-thrust use.

Supporting the Man-in-Space Program will be eight satellite attempts by Juno II (using the Jupiter missile) in 1959-1960, 10 Redstone upper-atmosphere vertical soundings, 2 Thor Ables, and 4 Vanguards.

During the forthcoming months of this year, the Advanced Research Projects Agency will launch several satellites, and by 1960 ARPA hopes to have a 6,000-pound communications satellite in a 22,300-mile-high orbit. This orbit would be the so-called "stationary" orbit since the satellite will appear to remain above a fixed point on the earth's surface.

Such a satellite might be launched by 8 Jupiter engines plus Atlas, Minuteman, or Titan upper stages. Clustered Jupiter engines also could place a 25,000-pound satellite in orbit near the earth or provide for moon probes. ARPA plans to orbit a satellite each month in 1959.

The Army's first moon probe—a Juno II—failed to reach the moon and returned to the earth. However, the attempt did yield data on the radiation belt in space on both the outgoing and return trip. Juno II consisted of a Jupiter IRBM first stage. Second stage was a cluster of eleven scaled Sergeant solid rockets, and third stage was a cluster of three scaled Sergeants. Fourth stage was a single Sergeant; finally, there was a payload of fifty-nine pounds.

Called Pioneer III, the lunar probe reached 66,654 miles into space on its 38-hour trip. In a subsequent flight, the Army shot a monkey 300 miles into space.

Missiles.—First full-range firing of the Atlas ICBM hit a range of 6,355 statute miles with the missile overshooting its target by about 30 miles. Bases for the Atlas are already under construction in Wyoming. Such Atlas bases are described as "soft" or above-ground launch sites. The other American ICBM—the Titan—recently had its first flight attempt. The missile failed to get off its Florida launch pad because of a thrust cutoff.

The Martin-built Titan is designed to be used in "hard" or underground launch sites. It is a 2-stage missile: the first stage has two Aerojet rocket engines which deliver a total of about 300,000 pounds' thrust; the second-stage is powered by one 60,000-pound-thrust rocket engine.

Meanwhile, the Air Force is asking industry to develop an air-launched, solid-propellant-rocket IRBM of 1,000-2,000 miles' range. Launch would come from a mother ship such as the B-47, B-52, or B-58 bombers. Prototypes of the missile, to be known as the Bold Orion, already have been tested by several industry teams, according to reports. The weapons system also will possibly be destined for use in the B-70 chemical bomber and in future nuclear aircraft.

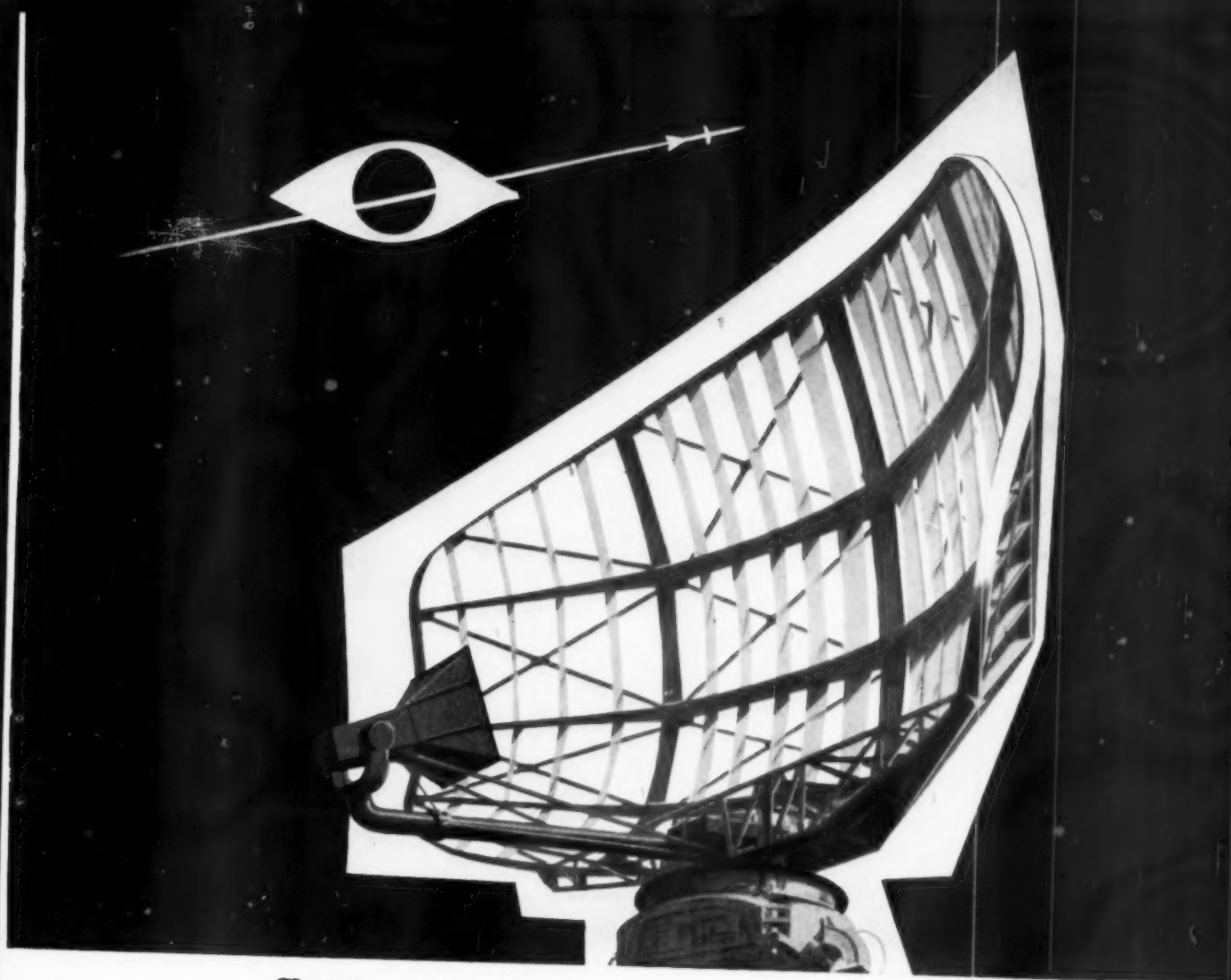
For this reason, it is believed, production of the Rascal short-range liquid-fueled, air-to-ground missile is being terminated. Success of the development of the Polaris solid-propellant, submarine-launched IRBM may be responsible for the discontinuance of the Regulus production program.

Propulsion.—A single-barrel rocket engine of 1 to 1.5 million pounds of thrust will be developed by the Rocketdyne Division of North American Aviation, Inc., under a projected $200 million contract recently granted by NASA.

The engine is understood to be slated to use the standard liquid propellant—liquid oxygen and a hydrocarbon fuel—that propels all present U. S. IRBM's and ICBM's. At some time in the future, however, it is possible that high-energy fuels or new oxidizers will be used. The million-pound-thrust rocket engine will be tested at Edwards Air Force Base in California.

Despite current emphasis on solid rockets, the Navy is pursuing a vigorous program of liquid rocket engine development at the Naval Air Rocket Test Station, Lake Denmark, N. J. It seems that the liquids under test are relatively insensitive to the temperature changes that are common with air-to-air rockets.

Biggest liquid rocket development activity is concerned with prepackaged liquids. These can be loaded at the factory and stored (like solid rockets) for long periods before firing.



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The whites of the enemy's eyes are now visible half-way around the earth... thanks to technological contributions from Stavid in the area of long-range ballistic-missile detection and high-power radars.

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Advanced warhead for Nike Hercules: developed, tested and produced by Rheem

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RECENT PATENTS

Compiled by Melvin Nord, patent attorney, Detroit, Mich. Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each.

Screen for Jet Engines.—*U. S. Patent No. 2,846,023. Issued August 5, 1958, to Victor Millman, Assigned to General Dynamics Corporation:* Prior to actual flight of an airplane, certain adjustments and checks must be made by ground-crew personnel which necessitates operating the engines while the plane remains on the ground. Suction created by a jet engine is of such force as to pick up debris or foreign material in the immediate vicinity of the engine air scoop, and, unless restrained, such debris is carried into the internal mechanism of the engine.

Due to the extreme high velocity of the air stream, small solid particles on the ground such as pebbles, stones, nuts, and bolts have caused considerable damage to or complete destruction of the engine. In an attempt to avoid such damage, ground-testing areas must be swept at frequent intervals in an attempt to rid them of material which might prove destructive.

The present invention provides a protective screen for use in connection with the air scoop of the engine during ground testing without restricting the air flow to a degree which would result in overheating the engine. The screen is detached from the air scoop before flight.

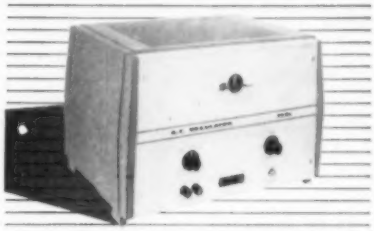
Rocket Decelerated Mine.—*U. S. Patent No. 2,848,945. Issued August 26, 1958, to Donald O. Brumbaugh, Assigned to the Secretary of the Navy:* This invention relates to a device for decelerating the forward velocity of a mine, whereby the mine may enter the water without damage to itself or to the delicate mechanism contained in it when launched at high or low altitudes from a fast-moving aircraft.

The decelerating force is produced by a rocket motor mounted in the nose of the mine, which includes a fuze which operates as the mine is dropped from the aircraft in flight. The rocket motor is initiated when the mine is a predetermined distance from the surface of the water, reducing its velocity prior to its entrance into the water.

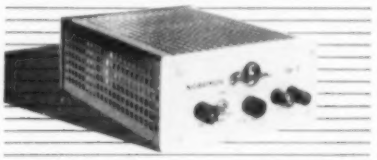
Bomb Safety Device.—*U. S. Patent No. 2,850,973. Issued September 9, 1958,* *(Continued on p. 810)*

NEW IDEAS IN PACKAGED POWER

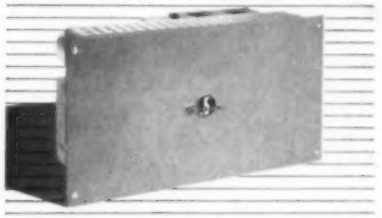
for lab, production test, test maintenance, or as a component or subsystem in your own products



0.01% regulation—Why be half safe? You can get a-c line voltage regulation to the exact degree of precision you need from Sorensen. Model 2501 (left) regulates a-c line voltage to ±0.01% at 2500 VA. Other Sorensen a-c models range in precision from meter calibrators to rugged "constant voltage transformers," designed to give you maximum volt-amps per dollar.



Fully-transistorized regulated d-c supplies—The most complete line of transistorized low-voltage d-c power supplies on the market—like the new Model Q6-2 (left)—is offered by Sorensen. Regulation accuracy is ±0.25% (line and load combined). Life is exceptional. Response speed is extremely fast. They come with voltage adjustable over 2:1 range (Model Q Series) in 6, 12, 28 vdc and capacities to 200 watts. Also in 0-36, or 0-75 vdc continuously variable "Rangers" (Model QR Series) of 150-watt capacity.



Here's a d-c workhorse for rack-panel equipment—New Sorensen Model MD supplies feature magnetic regulation, semiconductor rectifiers, capacitance-input filters—and low cost. What's more you get any factory preset voltage you want, from 2.5 vdc to 1000 vdc. Available in 8 sizes from 25 to 3000 watts. No switches, no fuses (short circuited output is not recommended, but is not damaging). Ideal for powering your 19" rack-panel equipment.

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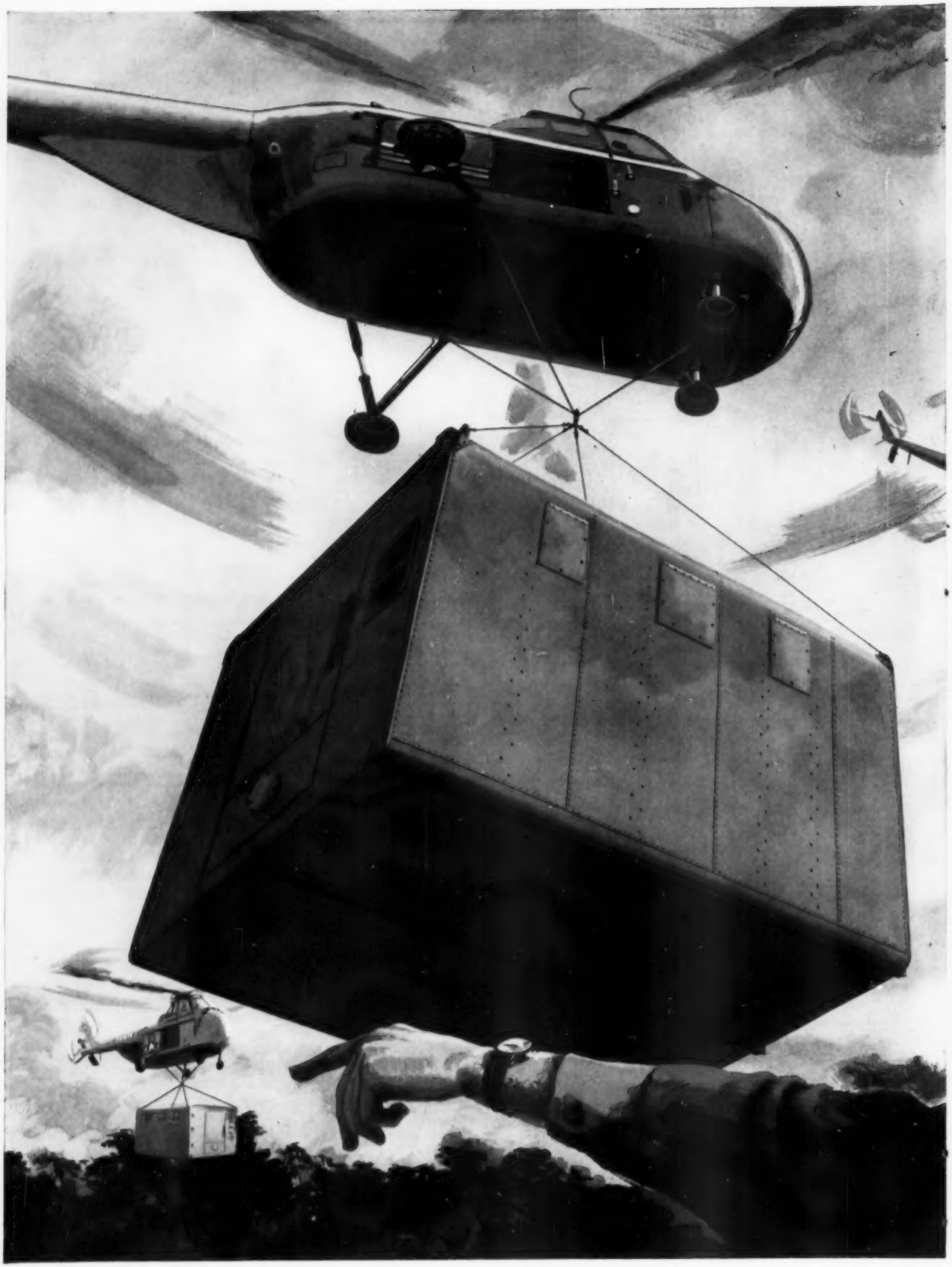

Tough, light Flynn extrusions frame "battle shelters" for electronic equipment

Drop them from helicopters. Bang them around in trucks. These "battle shelters" for electronic equipment are combat-ready. They're ribbed with tough, lightweight Flynn aluminum extrusions . . . for handling ease as well as ruggedness.

As a supplier for Gramm Trailer Corp. working for the U. S. Army, Flynn meets rigid standards. As in its work for other experts in our armed forces and industry, Flynn supplies quality extrusions formed to exact specifications.

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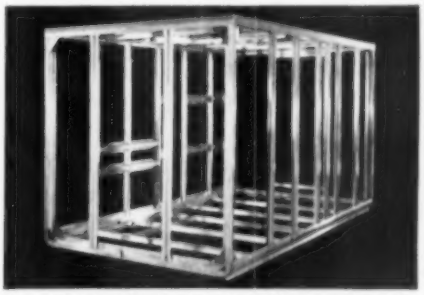
Plan, today, to investigate all the possibilities—all the advantages—of Flynn aluminum extrusions. Write, on your letterhead, for help, advice, and ideas. All free from Flynn, of course.



Flynn aluminum extrusions form the framework for Signal Corps Shelters made by Gramm Trailer Corp. After an aluminum skin is added, the finished "houses" for electronic equipment undergo drop tests. Designed in two different sizes, they can be carried by 2½ ton or ¼ ton trucks as well as by helicopter.

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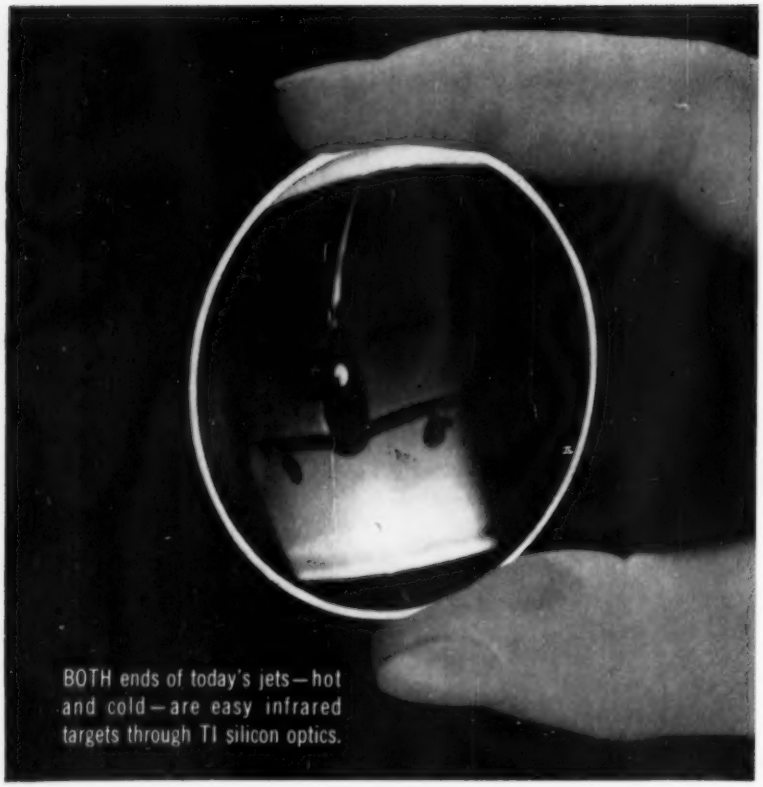
FLYNN ALUMINUM



BIRD'S IR VIEW...

of a Hot Stove Pipe

The wedding of optics to electronics may well be the marriage of the century... a TI-fostered union producing infrared guidance systems capable of finding, evaluating, rejecting false targets, and directing its "bird" to point-of-impact. Texas Instruments — leading producer of silicon optics for infrared applications — has achieved an intimate understanding of this and other unusual materials for specific portions of the spectrum.

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Recent Patents (Contd.)

to Evan D. Fisher and James E. Spates, Assigned to the Secretary of the Army: This invention relates to a device adapted to maintain a missile fuze safety wire in place until the missile is launched. Previously, the safety wire of a bomb fuze was retained in place within the fuze only by friction. Often the friction fails to provide the resistance required to prevent the premature removal of the wire from the fuze, considering the fact that the wire is in the slip stream of the airplane and subject to considerable force and "whipping."

Should the safety wire be removed from the fuze prematurely, the fuze would arm almost immediately, creating a serious hazard. The present invention provides a locking action in addition to the one provided by friction.

Guidance Device for Missiles.—*U. S. Patent No. 2,850,251, Issued September 2, 1958, to Wilbur A. Jaerndt, Assigned to Secretary of the Navy:* This invention provides apparatus for modifying target misalignment signals of a guided missile and for adjusting the position of the fins to correct for guide beam misalignment.

Fig. 1. Missile and guidance beams.

In Figure 1 there is shown an aerial missile 10 of either the rocket or ramjet type, having a number of fins 14 for steering the missile while it is in aerial flight along a trajectory and an antenna 13 mounted in one of the fins 14. A standard radar transmitter 11, located at a remote point and having a pulse repetition rate frequency modulated in synchronism with its scan rate, is utilized to project a guidance beam 8 of electromagnetic energy to guide the missile.

When the missile is not traveling centrally along the guide beam, input error signals are picked up by the antenna 13 and are fed to a guide beam error measuring device and then to a guide beam error signal modifying apparatus located within the missile.

Hypergolic Flame Thrower.—*U. S. Patent No. 2,851,094, Issued September 9, 1958, to Donald N. Griffin, Assigned to the Secretary of the Army:* This invention relates to a projector for ejecting hypergolic liquids. It is the object of the

(Continued on p. 811)

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Missile Ground Support **EQUIPMENT**

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When the Boeing Bomarc IM-99 is launched, FMC-built ground support equipment will be used.

Erectors, launch bases, flame deflectors and power control units, production-engineered and manufactured by FMC under a Boeing contract, automatically position the long-range surface-to-air missiles for firing.

FMC's capability for economical production, resulting from over 17 years' experience in designing and producing defense materiel, has effected important savings in the ground support equipment phase of the Bomarc program.

FMC will assume full responsibility for any phase of your missile ground support equipment project, fixed or mobile, from design concept through development, engineering and production. Long experience with military requirements and completely integrated facilities devoted exclusively to the manufacture of defense equipment are further assurance of on-schedule delivery. *Consult with FMC at the initial stage of project planning.* Contact us today for more information.

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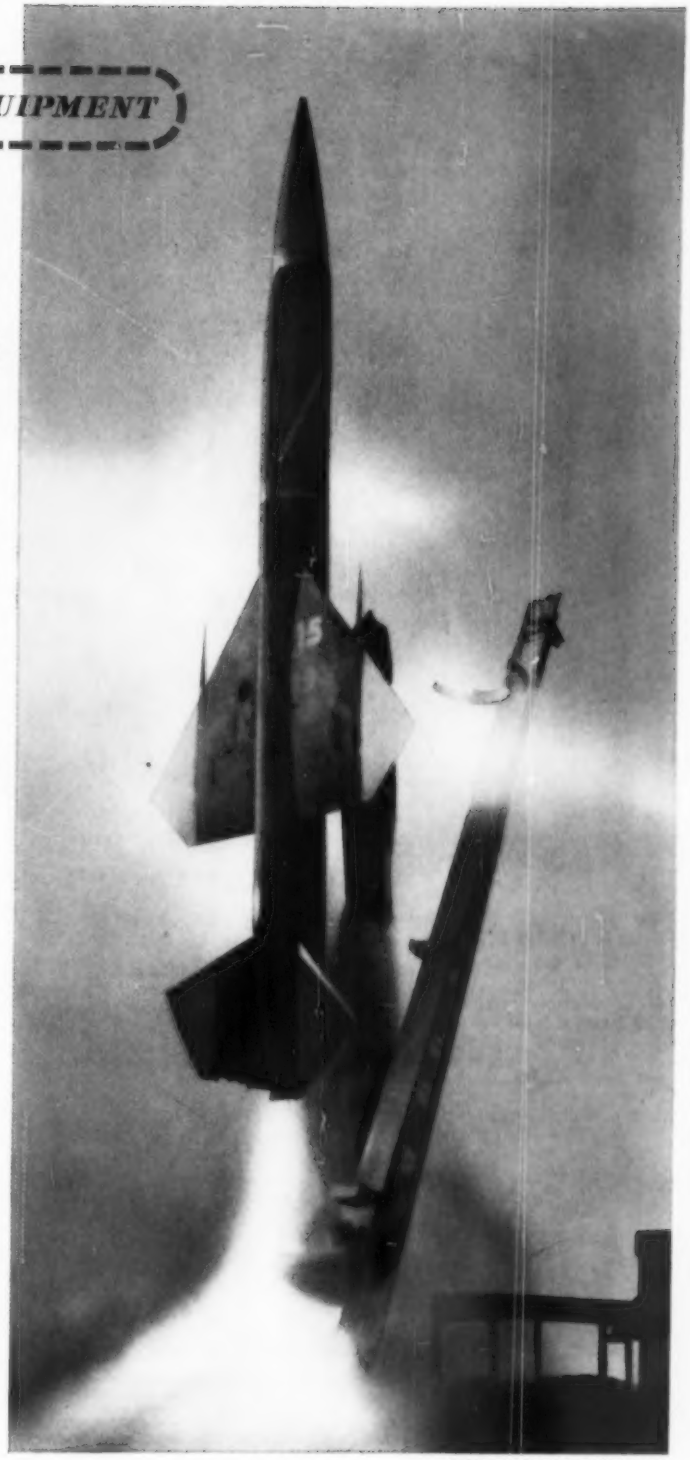

Operated by the Air Defense Command, a Boeing Bomarc climbs skyward from its launcher. FMC is building ground support equipment for this supersonic missile.

BOEING AIRPLANE COMPANY PHOTO

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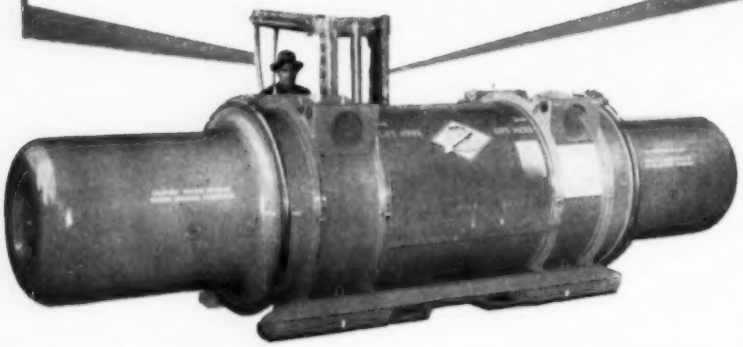
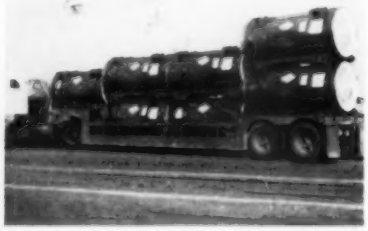


HARCO CONTAINERS ARE THE ONLY fiberglass containers approved by BuAer for handling in-flight refueling stores. Far lighter in weight than steel containers, they also transport the Harco developed ground handling trailer for moving of stores from container to aircraft. Type 1500 Harco Container is 18½-feet long, 4½-feet diameter. Unique design of end sections permits reversing and telescoping into center section for empty-return shipment, reducing length to less than 10-feet.

Harco Containers can be stacked three high for conservation of storage space; provision is made for sling or fork-lift-truck handling.



Note end sections reversed for empty shipment. Seven Harco containers with their integral ground handling trailers can be shipped in the same space required for three conventional containers.

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invention to utilize hypergolic bipropellant combinations ejected either in paralled or slighty converging streams so that ignition occurs when the propellants mix, without other igniting means. Flame temperatures approximate 3,000 degrees Kelvin, which is considerably in excess of gasoline-air flame temperature.

The operating valves can be opened simultaneously to produce ignition and stoichiometric flame. If flame persistence is desired, ejection of fuel only can follow the original ignition, in which case the fuel would air-burn at a reduced rate. Finally, when the target is of combustible material, initial bipropellant flame can be followed with ejection of oxidizer alone.

Forming Shaped Explosive Charges.—*U. S. Patent No. 2,851,918. Issued September 16, 1958, to Norman A. MacLeod:* In the casting of shaped charges from TNT or other thermoplastic explosives, it has been customary to pour the liquid explosive into a mold and to cool it from all surfaces equally to cause it to solidify. Because the mass is formed with a reentrant cavity, usually of conical form, this method of casting causes asymmetric crystal patterns which are not favorable to the formation of a uniformly advancing wave front upon detonation.

In the present invention, the liquid explosive is poured into the mold in the usual manner, but cooling takes place only on the inner surface of the cavity. Thus the crystal pattern develops symmetrically throughout the mass.

Underwater Explosive Container.—*U. S. Patent No. 2,845,833. Issued August 5, 1958, to Samuel H. Davidson and Thomas J. Reid, Assigned to Imperial Chemical Industries, Ltd.:* This invention relates to explosive elements for blasting under conditions of substantial hydrostatic pressure, in which the explosive charge consists of ammonium nitrate blasting explosive.

Compressible ammonium nitrate blasting explosives in tinplate or similar thin sheet-metal canisters when used under considerable hydrostatic pressures fail to provide effective internal support for the canister.

This is avoided in the present invention by packing a charge of an ammonium nitrate powder explosive containing a small amount of water into a thin sheet-metal canister, subjecting the canister after sealing to such a temperature and for such a period of time that the thin layer of the explosive which is closest to the sides of the canister attains a temperature which is the transition temperature for ammonium nitrate IV to ammonium nitrate III, and thereafter allowing the canister to cool so that the explosive which is at the transition temperature is converted into hardened explosive.

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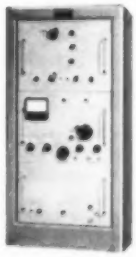
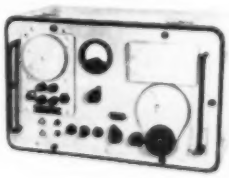
Hoffman test equipment checks TACAN accuracy—on the bench or in the cockpit*



HLI-103 BEACON SIMULATOR duplicates all functions of the AN/URN-3 surface beacon. Tests ARN-21 for full azimuth and entire range, closure and departure speeds, surface beacon identity tone and decoding functions. For bench test or cockpit check. Available on 60-day delivery.



HLI-119 TACAN TEST INSTRUMENT. Portable unit tests *accuracy* of ARN-21 airborne TACAN in the cockpit of aircraft on the ramp or carrier deck. Checks accuracy of range and bearing at pre-set points and identification signals. Availability on request.

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SPACE ARMAMENT

Captain Edwin E. Speaker, U.S.A.F.

Weather Data by Rocket.—Clear pictures from the first rocket camera unit designed specifically to photograph weather frontal systems and their associated cloud formations from extreme high altitudes over ocean areas where there are no permanent weather stations have been obtained from a successful firing and recovery of a Project Hugo Rocket.

The film, recovered at sea from the nose cone of the rocket which reached an altitude of 86.25 miles, shows the frontal cloud formations over an Atlantic Ocean area, starting about 200 miles off shore and stretching about 700 miles farther seaward. The mosaic strip, covering approximately 1,000 miles in length, compares roughly with the expanse between the southern tip of Maine and mid-Florida. The launch was made from the National Aeronautics and Space Agency's Pilotless Aircraft Research Station at Wallops Island, Va.

This was the first time that man had been able to look down from so high a vantage point on physical manifestations of the Norwegian weather front theory by which meteorologists have been forecasting the weather for the past forty years. These frontal cloud pictures were the best obtained from a rocket.

Project Hugo, conducted by the Office of Naval Research with funding assistance from the Bureau of Aeronautics and the U. S. Weather Bureau, is designed to further research into meteorological phenomena in an effort to improve the accuracy of weather predictions. It will also be of assistance to the U. S. Weather Bureau's Hurricane Weather Research Project in the field of hurricane photography.

Launching from the Wallops Island site was accomplished from a land-based installation of a shipboard-type Terrier missile launcher, and was effected without any delays or difficulty. Signals emitted by the nose cone's miniature transmitter were easily tracked by one surface ship and one aircraft, each carrying portable radio tracking equipment. Following its flight, the instrumentation package was successfully located and recovered from the sea by a destroyer.

First Spaceman.—The first human occupant of a satellite should be a small medical man or physiologist, according to Dr. Arthur Kantrowitz, director of Avco Research Laboratory. Dr. Kantrowitz revealed that Avco has proposed placing a manned satellite into a circular orbit at an altitude of about 100 miles. Provisions would be made for recovery either by air-drag devices or retarding rockets. A human would not be placed into orbit, however, until the entire system was proved reliable through flights with animals as passengers.

A medical man is deemed well suited for the assignment because he could best record his reactions to the stresses of space flight.

Space Weapons Systems.—According to the Hon. Dudley C. Sharp, Assistant Secretary of the Air Force: "At the outer perimenter of long-range hardware planning, extensive investigation is laying the groundwork for both piloted and unmanned space weapon systems. And notice here, I said *space weapon systems*. The Air Force is interested in space operations only in so far as a military application is concerned.

"Space exploration per se, is *not* the Air Force's business. The Air Force in time probably will become a space force. But the gap cannot be bridged overnight. It will be a slow, tedious, costly process to move outward from air operations to full space operations."

Along the same line, Gen. Thomas D. White, Air Force Chief of Staff, had the following comment: "What the Air Force already has accomplished in its ballistic missile effort, the X-15, and the Dyna-Soar project, form a good base for the military space projects of the future. I want to point out that Air Force efforts, experience, and capabilities in research on space operations are being oriented entirely toward development of military capabilities which will assure that we can extend our air superiority into space.

"We recognize that the Air Force mission in space is solely a military mission . . . one which requires us to develop and produce militarily useful vehicles. However, Air Force experience and capabilities will always stand ready to assist in other fields if they are needed."

Space Flight Tests.—At the opening session of the American Rocket Society's thirteenth annual meeting in New York, man's reactions to the stresses of space flight were discussed widely. In work being performed by Army researchers, the effects of an "8-hour day" on the individual were described. In these experiments the subject worked four hours and slept four hours. During the 168 hours that these tests were run, subjects showed intermittent periods of decreased efficiency, lack of interest, and visual distortion.

Air Force officers from the Aero Medical Laboratory at Wright-Patterson Air Force Base, Dayton, Ohio, reported that the alertness of an individual can be measured by the electrical resistance of his skin. By placing very low voltage electrodes on the soles of a subject's feet the researchers can measure both mental and physical activity and claim that this technique will even tell when the subject is asleep.

Manned Satellite.—Speaking of man in space, Hugh Dryden, deputy director of the National Aeronautics and Space Administration, stated at a recent press conference that NASA is considering proposals for a manned satellite. This vehicle would have a pressurized cabin and the occupant may or may not wear a fully pressurized suit. Dr. Dryden further stated that several probes will be fired soon in efforts to gain further knowledge of space. Confirmation of theories about the radiation fields around the earth is one of the immediate objectives of the space research program.

Air Force Research Vehicle.—The first X-15 research airplane was unveiled by North American Aviation, Inc., last fall. This rocket-propelled vehicle is designed to fly above the earth's atmosphere at altitudes in the neighborhood of 100 miles. Speeds up to 3,600 miles an hour are anticipated. This airplane, the first of three to be built, will begin flight testing in the near future.

Captain Speaker is a graduate of the U. S. Naval Academy and M.I.T. and was formerly chief of the Falcon Missile Project Office at Holloman Air Force Base, N. Mex. He is now with Headquarters, Air Research and Development Command, Andrews Air Force Base, Washington, D. C.

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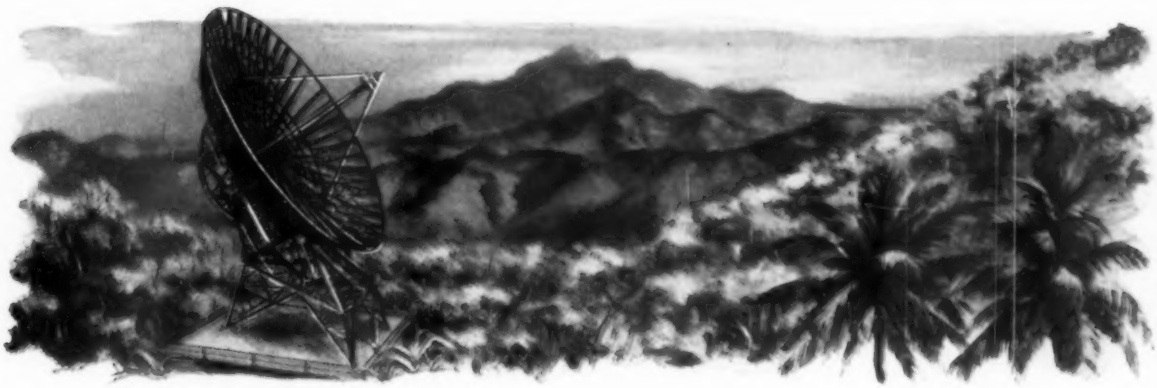

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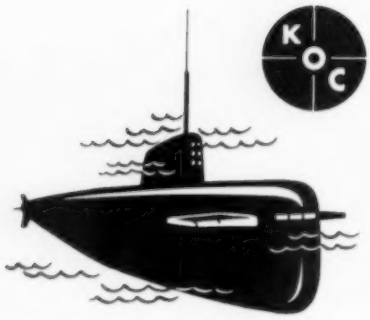

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ARMAMENT ELECTRONICS

W. H. Van Vliet

Inertial Navigation System.—The Navy's U.S.S. OBSERVATION ISLAND, first ship to test actual firing of the 1,500-mile range Polaris missile, will be fitted with highly advanced navigation equipment, including the ship's inertial navigation system (SINS). Rear Adm. W. F. Raborn, director of the Navy's Special Projects Office, states that successful firing of the Polaris to reach a target within its range requires continually reliable, precise determination of the ship's location.

The advanced navigation equipment installed on the OBSERVATION ISLAND has provided the answer to this problem. The nuclear-powered submarines using SINS will be able to navigate long distances for extended periods without reference to external radio, radar, or celestial fixes. SINS is jamproof, extremely accurate, and an entirely self-contained system.

Included on the OBSERVATION ISLAND and working with the Sperry developed SINS will be a navigation data assimilation center (NAVDAC). This system will take a wide variety of navigational data and, by digital-computer techniques, will collate, analyze, decode, and feed this information into the ship's navigation system to provide an effective firing base for the Polaris missile.

Q-Ball.—The Q-Ball is a new navigational device which will be used on the National Aeronautics and Space Administration's X-15 research vehicle. The new sphere-shaped servosensor has been under development at the Nortronic Hawthorne laboratories and has reached an advanced status. Q-Ball is designed to measure angle of attack, sideslip angle, and dynamic pressure at extremes of temperature, atmosphere, and Mach number. This device is the first such sensor to be used with a manned vehicle. It will enable the pilot to control the vehicle during its crucial reentry into the earth's atmosphere.

Space Probe Antenna.—The Advanced Research Projects Agency and the United States Air Force have recently received a proposal to measure the electronic density of space thousands of miles out. This will be accomplished by use of a 1,000-foot antenna which will be constructed by making a parabolic shaped hole in the surface of the earth and using a mesh-type reflecting surface. This antenna will be used in conjunction with high-powered radar transmitters.

Molecular Electronics.—The Air Research and Development Command is attempting an exploratory development of molecular electronics which is a new solid-state element capable of performing functions that now require many interconnected components. Several of the largest electronic manufacturers and research activities may be involved in this program which may open new frontiers in electronic research. *(Contd. on p. 820)*

Lieutenant Colonel Van Vliet, U.S.A.F. (Ret.), formerly director of armament electronics, Northeast Air Command, and formerly chief of the Operations Division, Air Force Ammunition Services, is an electronics systems engineer in the California Division, Lockheed Aircraft Corporation, Burbank, Calif.

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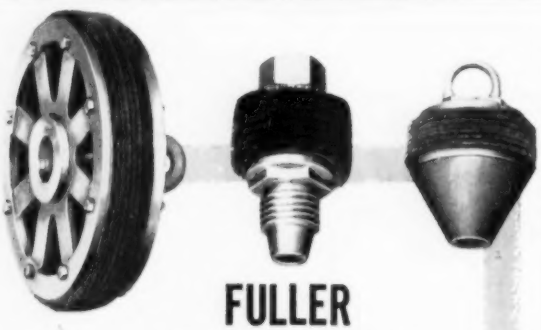

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Armament Electronics (Contd.)

Glide Slope Antenna.—A new instrument landing system glide-slope antenna is being developed under Civil Aeronautics Administration sponsorship. This new glide-slope antenna, which will be evaluated soon, may be placed in the runway whereas the present type of ILS antenna must be located on a high mast on one side of the instrument runway. This proposed antenna system will allow the pilot possibly to land the aircraft on a runway under no-visibility weather conditions.

Infrared Tracking.—It is reported that Sputnik III has been tracked successfully over Southern California by Aerojet-General Corporation using an infrared tracker mounted on a Navy gun mount. The purpose of the experiment was to aid in the design of infrared trackers for the Advanced Research Projects Agency's passive tracking networks. It may be that certain radiation characteristics of the Russian satellite were obtained during these experiments.

Meteor-Burst Transmissions.—Stanford Research Institute has been carrying on experiments under U.S.A.F. sponsorship for some time, using meteor-burst scatter techniques to transmit VHF signals over distances greater than 1,000 miles. This type of communication is relatively free from jamming and direction-finding and is able to transmit voice, facsimile, and teletype over great distances with low power. The meteor-burst technique utilizes messages stored on magnetic tape which are transmitted at accelerated rates during the small intervals during which a meteor trail exists to serve as a reflecting surface.

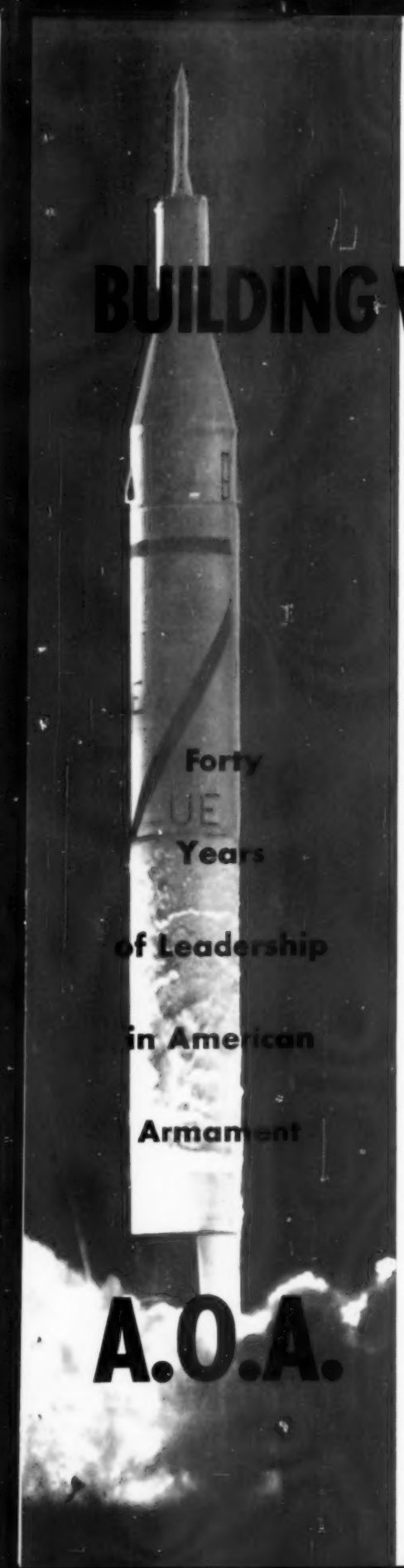
High-Temperature Transistors.—The Wright Air Development Center is sponsoring the development of diodes in transistors for operation at 400 degrees centigrade, using new semiconductor materials, such as gallium arsenide, and indium phosphide. It is reported that some gallium arsenide rectifiers have been developed which will operate at 350 degrees centigrade.

Missile Range Safety System.—Vandenberg Air Force Base, Calif., recently received a missile-tracking and impact-prediction system which provides range safety and will assure immediate destruction of off-course missiles. This system will predict the area of missile impact from the moment of firing which will allow safety officers to explode a stray missile in flight. A system of this type is extremely essential in any missile test center since any city in the world could possibly be reached by an off-course missile. International incidents occurring from such cases would have serious implications.

This impact-prediction system, developed by Packard Bell, takes information from radar trackers, converts it into a form compatible with a general-purpose computer, computes the missile position and impact point, and presents the resulting data on four plotting boards. The information is also recorded on tape for flight simulation or later evaluation. If the missile departs from a safe course, as shown on the plotting boards, it can be detonated readily by the range safety officer.

Space Memory.—A tiny, rugged tape recorder, able to store 3,000 bits of scientific data as it travels through outer space, has been developed at the Lockheed Missile System Division research laboratory. This recorder, small enough to be held in one hand, is a masterpiece of miniaturization and answers the need for a lightweight, versatile communication unit for space missions. It will be a valuable piece of equipment for lunar probes, manned or unmanned space craft, and for interplanetary vehicles.

The recorder can record and store data of the universe during long periods when the space craft is out of direct radio contact with the earth and then transmit at an accelerated rate on a command signal when the vehicle returns into range of the earth's listening point.



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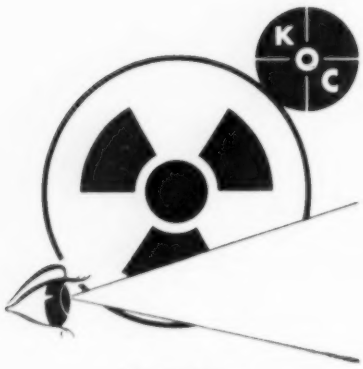

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Book REVIEWS

Reviews in this issue by:

COL. GEORGE S. BRADY, *consulting engineer, author, editor, Washington, D. C.*

COL. LEO A. COMB, *editor, Washington, D. C.*

DR. JAMES B. EDSON, *assistant to director, Research and Development, Office, Secretary of the Army, Washington, D. C.*

MAJ. GEN. E. P. MECHLING, *aviation ordnance expert, editor, Washington, D. C.*

DR. JOHN J. O'CONNOR, *educator, author, editor, Washington, D. C.*

LIEUT. COL. S. M. SMOLENSKY, *engineer, Andover, Mass.*

Wedemeyer Reports! By Gen. Albert C. Wedemeyer. New York: Henry Holt & Company. 497 pp. $6.

UNDOUBTEDLY there will be two schools of thought about General Wedemeyer's frank and dispassionate examination of our World War II and postwar strategy. He is well known as the gallant and skilled planner who assisted Gen. George C. Marshall, then Chief of Staff of the Army, in the over-all analyses and requirements of the victory program. He participated in the inner councils at the White House and at many of the historic conferences including Casablanca, Quebec, and other meetings of world-shaking significance. General Wedemeyer always has been known and admired for his ability and for his forthrightness. His book displays both qualities to the full.

The one school of thought on what this very able soldier has written will not hesitate to continue its admiration for his fearlessness in calling the shots as he sees them. The other, while no less ardent in admiration, will regard some of his narrative as worthy of more detailed check before pen was put to paper.

There may be no division of opinion regarding the Wedemeyer contributions to the momentous events of World War II days. These include his services in China as successor to Gen. Joseph Stilwell, his close cooperation with Ambassador Patrick J. Hurley, and his constant fight against Communism during hostilities, immediately thereafter, and since. In the latter area he continues to render outstanding service to our country and to humanity.

The greatest contribution of General Wedemeyer's text is the evidence it affords of the crying need for a continuing policy of grand strategy for the United States of America. The glaring lack of such strategy preceding, during, and following World War II is stark evidence of one of our greatest national deficiencies. Nor is there much assurance that under today's procedures the errors of our past have been corrected.

Some may argue that a democracy contains within itself the reasons why a continuing grand strategy can never be assured. If this be so, General Wedemeyer's valuable volume indicates the inescapable conclusion that the forces of democracy cannot expect to defeat the forces of Communism. We had best learn well the lesson he teaches, for it is the most serious that faces our generation.—LEO A. COMB. *(Continued on p. 824)*

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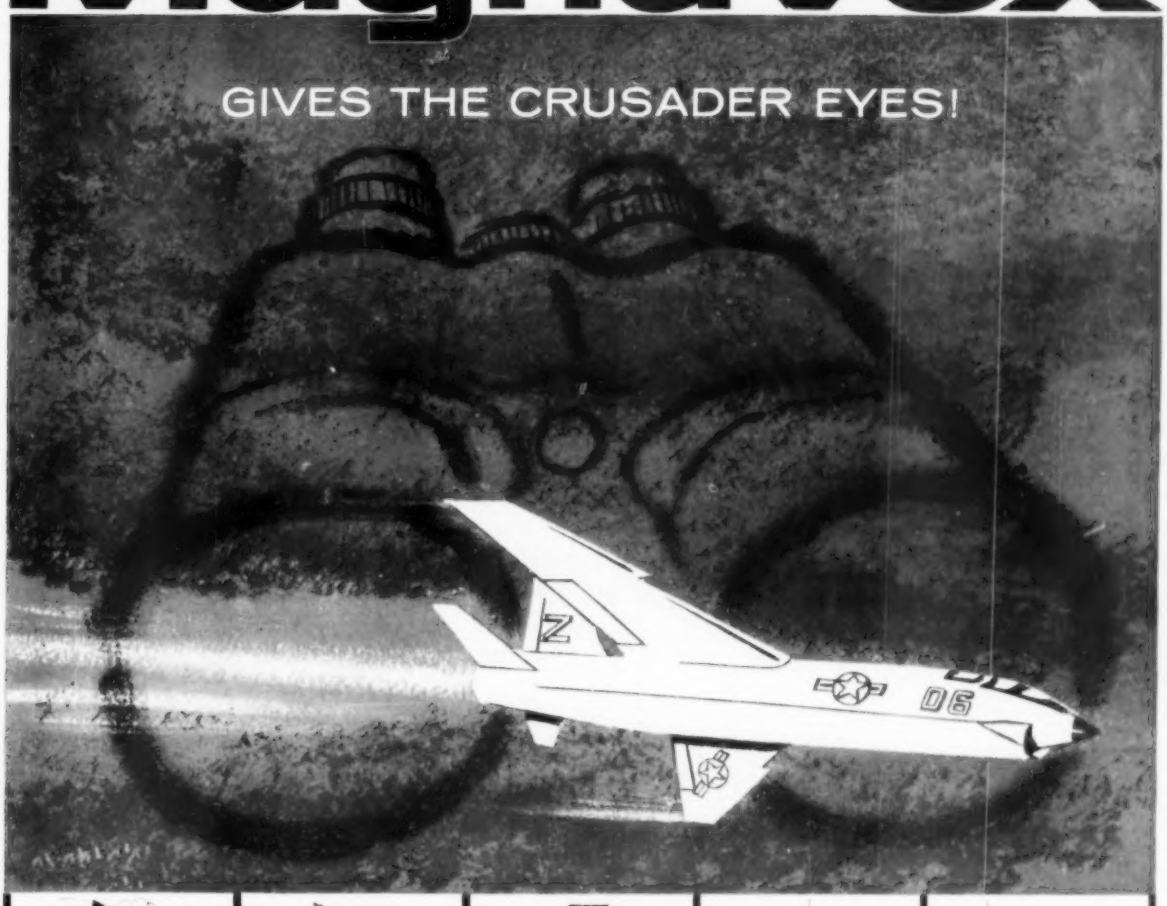

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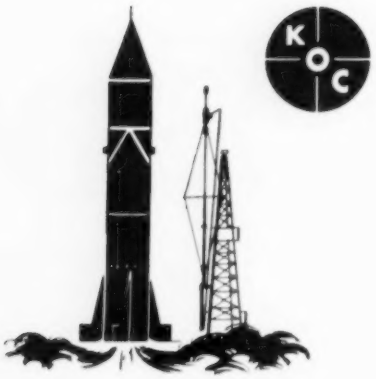

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Book Reviews (Contd.)

Nautilus 90 North. By Comdr. William R. Anderson, U.S.N., with Clay Blair, Jr. Cleveland: World Publishing Company. 251 pp. $3.95.

THIS is the intensely interesting record of one of the great adventure stories of our century and one of the most remarkable voyages in the history of man. The title of the book derives from the three-word message which Commander Anderson, captain of the nuclear-powered submarine NAUTILUS, sent to the Chief of Naval Operations, informing him that the submarine had reached the North Pole and was then completing the first transpolar voyage from the Pacific to the Atlantic.

A great many people share the honor of this brilliant American achievement. But it was Commander Anderson and his dauntless crew who probed the polar ice in 1957, made an unsuccessful attempt to get through in June of 1958, and finally accomplished the difficult feat three months later. The voyage opened the possibility of a new commercial seaway and immeasurably strengthened our defense position.

Commander Anderson, a veteran submariner, was chosen by Admiral Rickover for a difficult assignment. He spent a year in Rickover's office in Washington where he brought himself up to date on nuclear power and Arctic exploration. The greater part of the book deals with the secret and elaborate preparations that were made for the daring voyage and the dramatic and vexing events on NAUTILUS that preceded the skillful thrust into the unknown.

Operation Sunshine was a nerve-wracking project that was carried through with vision, competence, and immense courage. When NAUTILUS reached the Barrow Sea Valley, the deep-water gateway to the Western Arctic Basin, Commander Anderson was confident that at last he had it made. The transit of 1,830 miles was completed in 96 hours.—JOHN J. O'CONNOR.

The Soviet Navy. Edited by Comdr. M. G. Saunders, R.N. New York: Frederick A. Praeger. 340 pp. $7.50.

"IN a future war the struggle at sea will be of even greater importance than it was in the last war," said Marshal Zhukov, Soviet Minister of Defense, in February 1956.

Since World War II the Soviet Union has done nothing to minimize the significance of the above statement. The Soviets now have ten times as many submarines as Germany could put to sea in 1939. This fact alone makes a knowledge of the strategic, geopolitical, and technological implications of Soviet sea power indispensable to one seeking an insight into East-West relations.

To date, specific information on Russian sea power has been scanty and in many cases self-contradictory. "The Soviet Navy" is an attempt to present the first authoritative and comprehensive survey of Russian naval power from the demoralized and beaten Navy of World War I to the second ranking navy of today.

A distinguished international team of experts including British, American, French, and German authorities covers all aspects of Russian naval affairs including the present size of the Soviet Navy, location of bases, training of personnel, and comparison of effectiveness with other navies of the world.

The greater part of this book deals with the present, with such experts as Hanson Baldwin, Admiral Eller, U.S.N., and Admiral Nichol, R.N., discussing the broad aspects of Russian naval strategy and the nature of the threat it poses to the West. —S. M. SMOLENSKY.

Up Came Hill—The Story of the Light Division and Its Leaders. By Martin Schenck. Harrisburg: Stackpole Company. 344 pp. $5.75.

WHILE the North made the mistake during the first two years of the Civil War in keeping its Regular Army almost in-

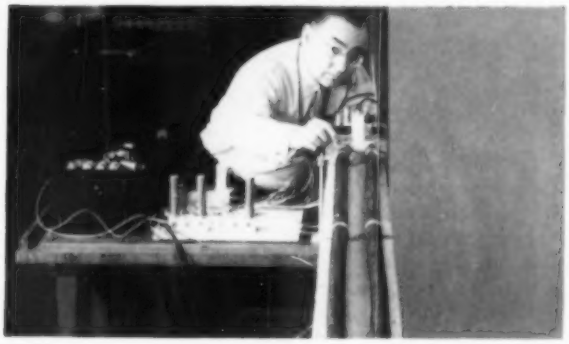
THEY PROBE THE FUTURE OF DEEP-SEA TELEPHONY

"Dry Land Ocean," under construction at Bell Laboratories, simulates ocean floor conditions, is used to test changes in cable loss. Sample cables are housed in pipes which contain salt water under deep-sea pressure. The completed trough is roofed in and is filled with water which maintains the pipes at 37° F., the temperature of the ocean floor.

Deep in the ocean, a submarine telephone cable system is extremely hard to get at for adjustment or repair. This makes it vitally important to find out what can happen to such a system *before* it is installed.

Bell Laboratories engineers do this by means of tests which simulate ocean floor conditions on dry land. Among many factors they test for are the effects of immense pressures on amplifier housings and their water-resistant seals. They also test for agents which work very slowly, yet can cause serious destruction over the years—chemical action, marine borers and several species of bacteria which strangely thrive under great pressures.

Through this and other work, Bell Telephone Laboratories engineers are learning how to create better deep-sea telephone systems to connect America to the rest of the world.



Highly precise instruments developed by Bell Laboratories engineers are used to detect infinitesimal changes in cable loss—to an accuracy of ten millionths of a decibel.

Seawater and sediment in bottle characterize ocean floor. Test sample of insulation on coiled wire is checked for bacterial attack by conductance and capacitance tests.

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Where hit or miss means life or death, Kollmorgen fire control devices put the projectile on target and keep it there. Combining optical, mechanical and electronic skills, these devices demonstrate the type of highly precise instrumentation work Kollmorgen is prepared to do for you. For literature on fire control write to Department 51M.

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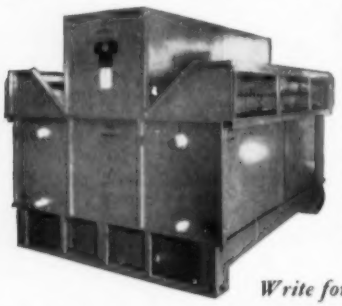
● Niagara *Aero* Heat Exchanger offers a completely self-contained system independent of any considerable water supply, replacing both shell-and-tube cooler and cooling tower. Water consumption is only the evaporation and the small amount passed as blowdown to prevent hardness build up. Net saving is 95% of water used in cooling from external sources. You solve the problem of water supply and disposal; you save much additional expense and equipment in water handling, piping, pumping.



Casing panels are removable with full access to all parts and interior piping for easy inspection. Sections are shipped as flat panels with saving in freight charges.

Write for Bulletin No. 132

NIAGARA BLOWER COMPANY
Dept. 0-3, 405 Lexington Ave., New York 17, N. Y.

Book Reviews (Contd.)

tact as a unit, the South gave high rank to West Pointers and utilized them to provide trained leadership to the whole army. Capt. A. P. Hill, U.S.A., was immediately commissioned a colonel, C.S.A., and soon advanced to the rank of major general. Although this young officer had no previous battle experience, he was rated by Lee and by Jefferson Davis as the top divisional commander of the entire Confederate forces. He was not given higher rank only because it was not politically expedient to designate more top commanders from Virginia.

The book does not have the free-flowing style of the conventional Civil War book. It is more labored in its diction, but the student of military tactics will find that it contains more useful meat than the ordinary war books. Strategic and tactical data on the various battles have been more carefully examined here than is usual in works of this kind. Probably the greatest value in the book will be found in the intimate character studies of the leaders in both armies.

Unquestionably, the continual victories of the Confederates during the first two years were due mostly to the incompetence of the Union leaders who had far superior forces and superior equipment. While Lee considered the bombastic General Pope as "little better than a vermin which ought to be suppressed," his opinion of McClellan was more of pity. During the Seven Days' Battles, McClellan continuously withdrew before weaker forces, permitting the Confederates to reequip and feed themselves from the supplies he left behind.

The book is not easy reading but it is well recommended as a text for military students.—GEORGE S. BRADY.

The Story of Aviation. By David C. Cooke. New York: Archer House. 256 pp. $4.95.

THE author has written an absorbing story, condensing the history of man's attempt to fly into 256 pages of text and illustrations. He has handled this story with unusual competence and skill, tracing the history of flight from man's first aspirations and dreams of emulating birds to the fantastic accomplishments of today's aircraft.

The many failures of the past centuries and the difficulties in identifying the meager early successes are vividly told. Early experimenters were unsure of their theories and lacked confidence in their results until the Wright brothers first demonstrated powered flight. This achievement created the confidence necessary to get a considerable number of people making and flying aircraft within a few years.

The public interest in these early successes provided wide distribution of available technical data. This cumulative experience as analyzed by scientists and engineers provided the key to further advancement, and the rate of advancement of the science of aviation is still increasing.

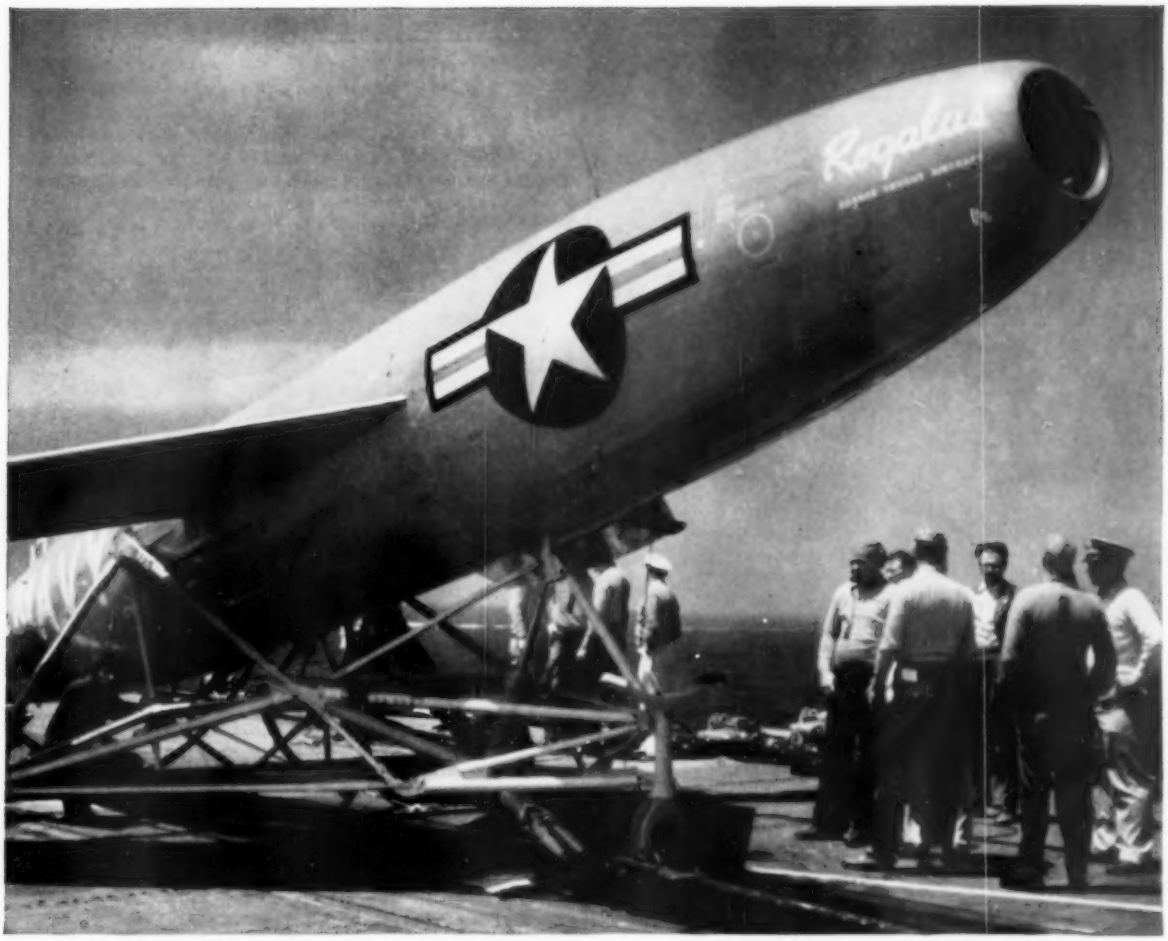
The performance of aircraft, the men who made them, the men who flew them (for peaceful purposes as well as for wartime combat) is here described with a feel for the excitement which permeated the entire effort.

This brief history of aviation will be enjoyed and appreciated by the reader regardless of how much he knows about the subject.—E. P. MECHLING.

Henry Knox—General Washington's General. New York: Rinehart & Company. 404 pp. $6.

UNDOUBTEDLY much of the success of the Continental Army was due to the vigor and organizational ability of General Knox. In addition to his position as Chief of Artillery during the entire war, he was at all times close to General Washington where his constant drive, continually cheerful and optimistic nature, and his wide capacity for organization were of great service to the Commander in Chief.

It was Knox who suggested equipping the Army with the



Checking Regulus I surface-to-surface missile prior to launching from experimental cart. For the use of Ni-Cr-Mo steel castings in the launching cart, Chance Vought was judged a National Award Winner in the Third Product Development Contest conducted by the Steel Founders' Society of America.

How castings of 4330 nickel-alloyed steel help boost a missile up, push assembly cost down

20-Ni-Cr-Mo steel castings replace 73 detail parts, eliminate 300 hardware items in new launching cart

Regulus I, made by Chance Vought, is normally boosted skyward from a rail launcher. The Navy, however, wanted a more economical launching technique that would utilize a carrier's powerful catapults . . . that would also simplify handling of the missile aboard ship.

The answer was the expendable catapult cart you see above.

The carts, also made by Chance Vought, are assembled with 20 cast 4330 steel cluster joints welded to tubing of the same material. These castings replaced 73 detail parts required in the plate-type fittings of the experimental units used to prove the idea. They also eliminated 300 hardware items, such as nuts and bolts. Assembly is easier, and far more economical.

Why Ni-Cr-Mo steel for the castings? The 4330 composition of 1.8% Ni .65% Cr. .25% Mo heat treated to 125,000 and 150,000 psi gives these castings the combination of high strength and great toughness needed to stand up to the tremendous shock of take off.

What about your product? Can it use the economy, high strength, and shock resistance offered by Ni-Cr-Mo steel castings? You can get complete information by writing:

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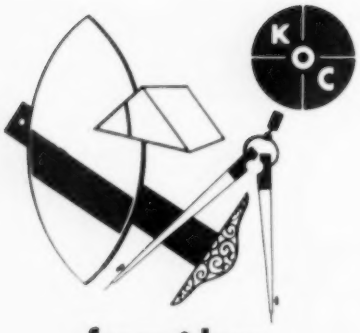

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INDEX TO ORDNANCE

VOLUME XLII

● The Index to Volume XLII of ORDNANCE, with title page for binding, is now available. It will be sent free of charge upon request to the Editorial Offices at the address below.

● It covers subjects in the following 1957 and 1958 issues: July-August (No. 223); September-October (No. 224); November-December (No. 225); January-February (No. 226); March-April (No. 227); and May-June (No. 228). It is arranged alphabetically by subject and author.

AMERICAN ORDNANCE ASSOCIATION
708 Mills Building • Washington 6, D. C.

Book Reviews (Contd.)

British guns captured by Stark at Ticonderoga, and it was Knox who dragged the guns to Boston across the snow-covered mountains. It is also suspected that it was with moral support of General Knox that the rough-and-ready Colonel Stark admonished General Washington on Christmas Eve 1776, for permitting his army to rely too much on spades and pickaxes, and urged him to teach his men to rely on their courage and their firearms. Washington took the lesson to heart, and the very next night led his men across the river in a blinding sleet storm to win the victories of Trenton and Princeton.

The book gives many intimate details of the leaders of the Continental Army and the early American Government. But probably the most useful phase of the book for the student of military affairs is the manner in which Chief Artillerist Knox was able to build up a superior artillery force with little means or skill at his disposal. The book is an interesting study of our first ordnance experience.—GEORGE S. BRADY.

T. R.—Champion of the Strenuous Life. By William Davison Johnston. New York: Farrar, Straus & Cudahy. 141 pp. $3.75.

THIS brief biography of Theodore Roosevelt attempts to recreate the many facets of his adventurous life. It does this in three ways—by fifty or sixty excellent photographs, covering every phase of his career; by apt quotations from his speeches and writings; and by a brief chronicle of the explorer, author, and scientist who became the twenty-sixth President of the United States.

One of the great causes to which Roosevelt dedicated himself was national preparedness. As Assistant Secretary of the Navy on the eve of the Spanish-American War, he converted our peacetime naval force into an efficient combat organization. As President, he believed that naval strength was the key to national survival and the only basis for an effective foreign policy. Prior to World War I he tried to rouse the country from its pacifist lethargy. When hostilities were declared, he immediately offered to raise two divisions for immediate service.

Theodore Roosevelt will always be remembered as a valiant leader and a great creative spirt. Mr. Johnston has succeeded admirably in portraying a dynamic personality who spent himself, generously and joyfully, in the great adventure of life.—JOHN J. O'CONNOR.

The Strange Ordeal of the Normandier. By H. L. Tredree. Boston: Little, Brown & Company. 231 pp. $3.95.

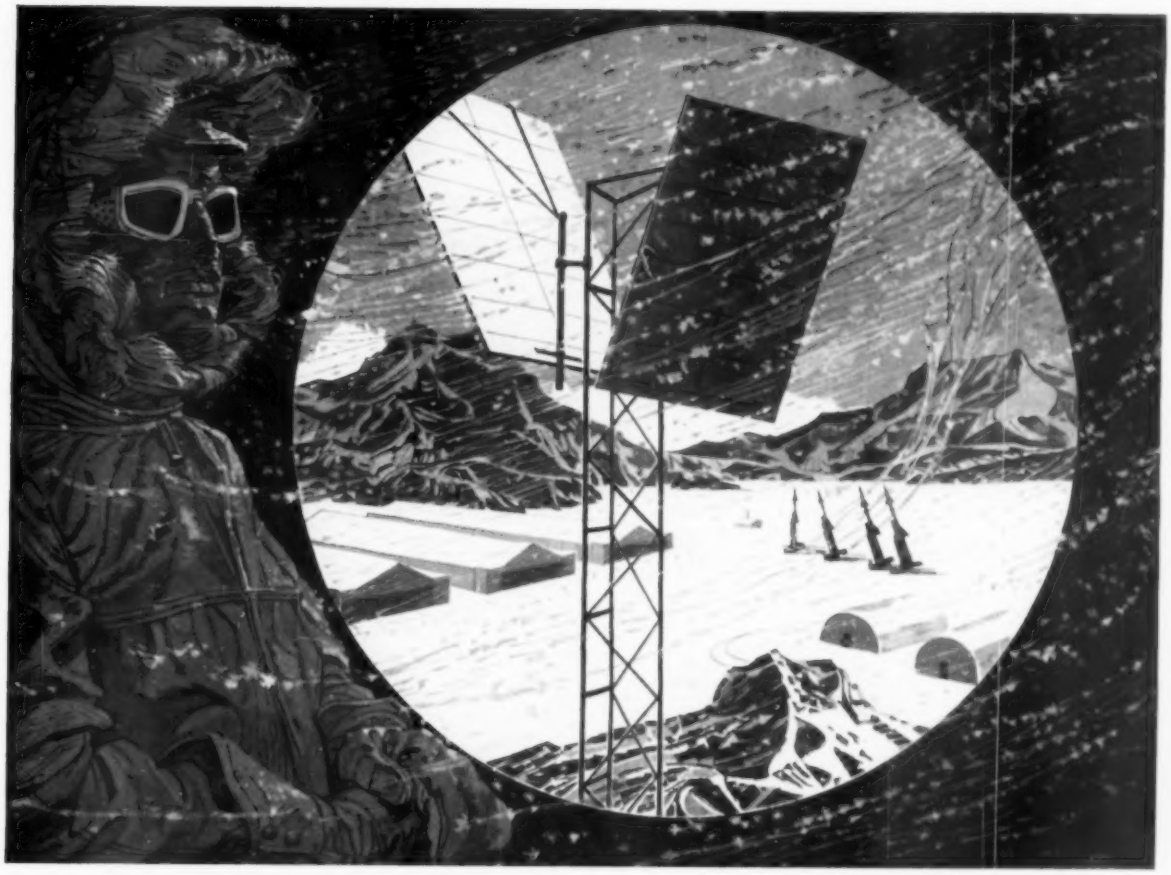
THIS is the story of a tough old tramp steamer with a still tougher crew assigned to carry cargoes during World War I. The crew contracted blackwater fever at Dakar, but still attempted to make the long trip to Canada. When the ship was finally rescued in midocean by an American vessel, it was hopelessly adrift with engines stalled, most of the men and officers dead, and only two survivors conscious.

Many interesting details of the wartime cargo service, and the terrors of the deadly fever, are given. The outstanding feature is the manner in which the hard-boiled men of the crew showed a remarkable and kindly charity in helping each other during the ravages of the plague. The way in which two of the desperately sick men struggled to get up steam in the donkey boiler so that a radio call for help could be sent out is only one of the many incidents delineated here.—GEORGE S. BRADY.

Dynamical Analogies. Second edition. By Harry F. Olson. New York: D. Van Nostrand Company. 278 pp. $6.75.

THE appearance of a second edition is excellent testimony to the acceptance and continuing usefulness of a book. This work has earned a second edition because it is obviously a very practical aid to working design engineers. *(Continued on p. 830)*

Voice of defense in the North



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Book Reviews (Contd.)

The chapters on noise, distortion, and feedback, new in this edition, add substantially to the value of the book. Concise and lucid, this volume is a contribution by a working engineer to make easier and more effective the labors of his colleagues. —JAMES B. EDSON.

BOOKS RECEIVED

Fundamentals of Advanced Missiles. By Richard B. Dow. New York: John Wiley & Son, Inc. 567 pp. $11.75.

Guide to the Literature of Mathematics and Physics. By Nathan Grier Parke, III. New York: Dover Publications, Inc. 436 pp. $2.49.

Guide to Nuclear Energy. By R. K. Belchem. New York: Philosophical Library, Inc. 77 pp. $3.75.

Ill-Starred General: Braddock of the Coldstream Guards. By Lee McCardell. Pittsburgh: University of Pittsburgh Press. 335 pp. $6.

Kaiser Aluminum Foil. First Edition. Compiled by John W. Knight. Chicago: Kaiser Aluminum & Chemical Sales, Inc. 234 pp. $12.50 for personal use; copy sent free upon request on company letterhead stationery.

Liquids and Gases. By Alexander Efron. New York: John F. Rider Publisher, Inc. 128 pp. $2.10.

Metallic Rectifiers and Crystal Diodes. By Theodore Conti. New York: John F. Rider Publisher, Inc. 164 pp. $2.95.

Naval Leadership. By Comdr. Malcolm E. Wolfe, *et al.* Annapolis: U. S. Naval Institute. 302 pp. $3.50.

Nuclear Tactics. By Col. T. C. Mataxis and Lieut. Col. S. L. Goldberg. Harrisburg: Military Service Publishing Company. 254 pp. $3.50 (paper), $4.25 (cloth).

Pearl Harbor to Guadalcanal. History of the U. S. Marine Corps Operations in World War II. Vol. I. By Lieut. Col. Frank O. Hough, Maj. Verle E. Ludwig, and Henry I. Shaw. Washington: U. S. Government Printing Office, 439 pp. NP.

Permanent Peace. By Tom Slick. New York: Prentice-Hall, Inc. 181 pp. $2.95.

Radioactivity Measuring Instruments. By M. C. Nokes. New York: Philosophical Library, Inc. 75 pp. $4.75.

Rocket Propellants. By Francis A. Warren. New York: Reinhold Publishing Corporation. 218 pp. $6.50.

Service Etiquette. By Rear Adm. Bruce McCandless *et al.* Annapolis: U. S. Naval Institute. 365 pp. $5.50.

Seven Roads to Moscow. By W. G. F. Jackson. New York: Philosophical Library, Inc. 334 pp. $7.50.

Social Impact of Bomb Destruction. By Fred Charles Ikle. Norman: University of Oklahoma Press. 250 pp. $3.95.

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At Temco, the integration of diverse skills works to create unusual capabilities for the aircraft, missile and electronic industries. This coordination of specialties in a team effort is a major reason why Temco is well respected as a source of prime weapons systems and recognized as one of the nation's most efficient sub-contract and overhaul agencies.

Temco's combined talents are being applied continuously to the development of new materials, processes and production techniques. In the field of high temperature structures, integration of skills has resulted in an outstanding development — Temcombing — the company's own unique process for fabricating stainless steel honeycomb. Temcombing permits panels of virtually unlimited size, thus reducing weight and critical tolerance errors. In short, this new Temco development is the fastest, most advanced, most economical method for brazing stainless sandwich developed to date — a notable example of Temco's ability to extend capabilities.

Temco's ability to design, tool and produce the *total package* plus the capability to go beyond the immediate problem have given the spacecraft industry good reasons to team up with Temco.

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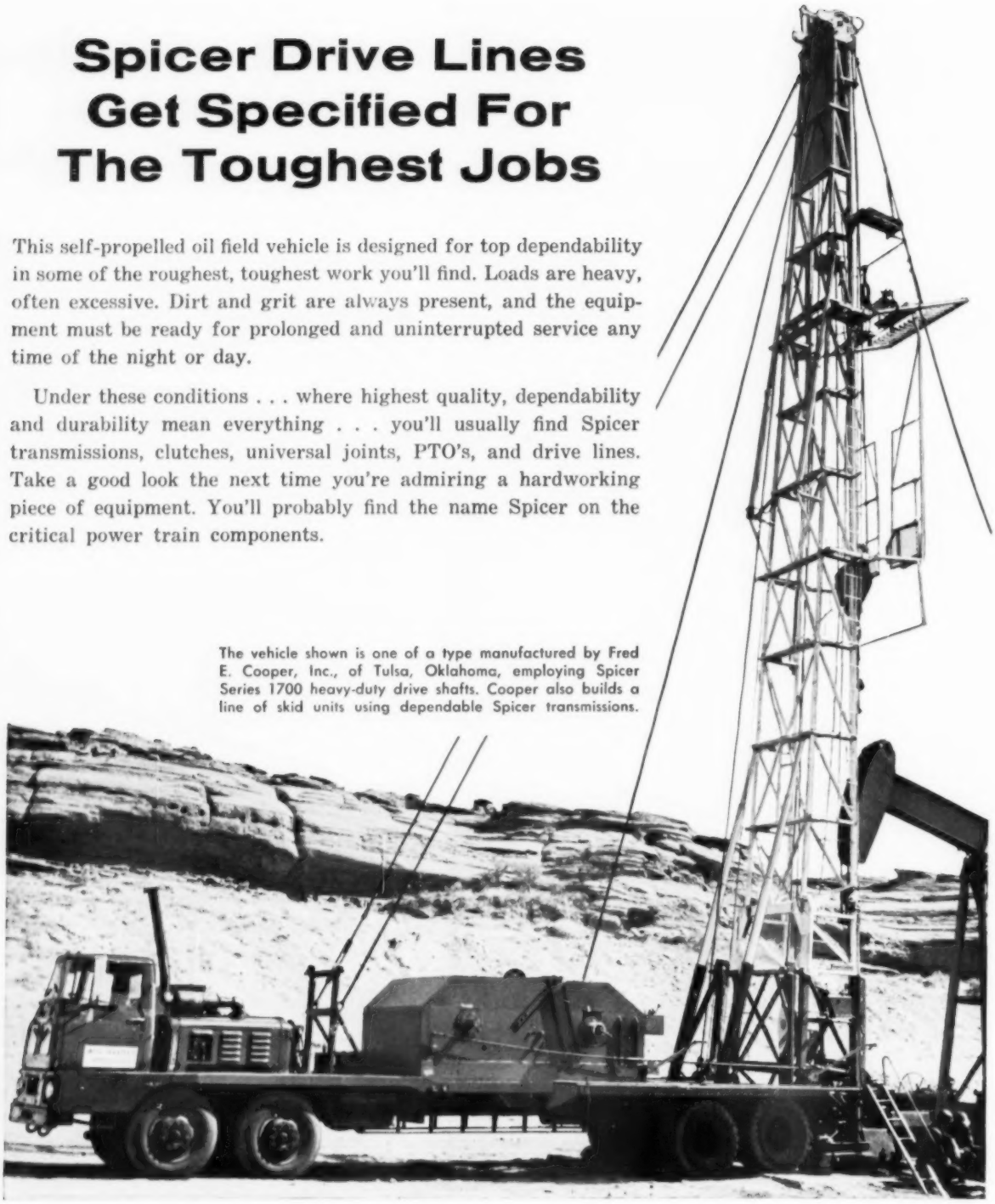
Under these conditions . . . where highest quality, dependability and durability mean everything . . . you'll usually find Spicer transmissions, clutches, universal joints, PTO's, and drive lines. Take a good look the next time you're admiring a hardworking piece of equipment. You'll probably find the name Spicer on the critical power train components.

The vehicle shown is one of a type manufactured by Fred E. Cooper, Inc., of Tulsa, Oklahoma, employing Spicer Series 1700 heavy-duty drive shafts. Cooper also builds a line of skid units using dependable Spicer transmissions.



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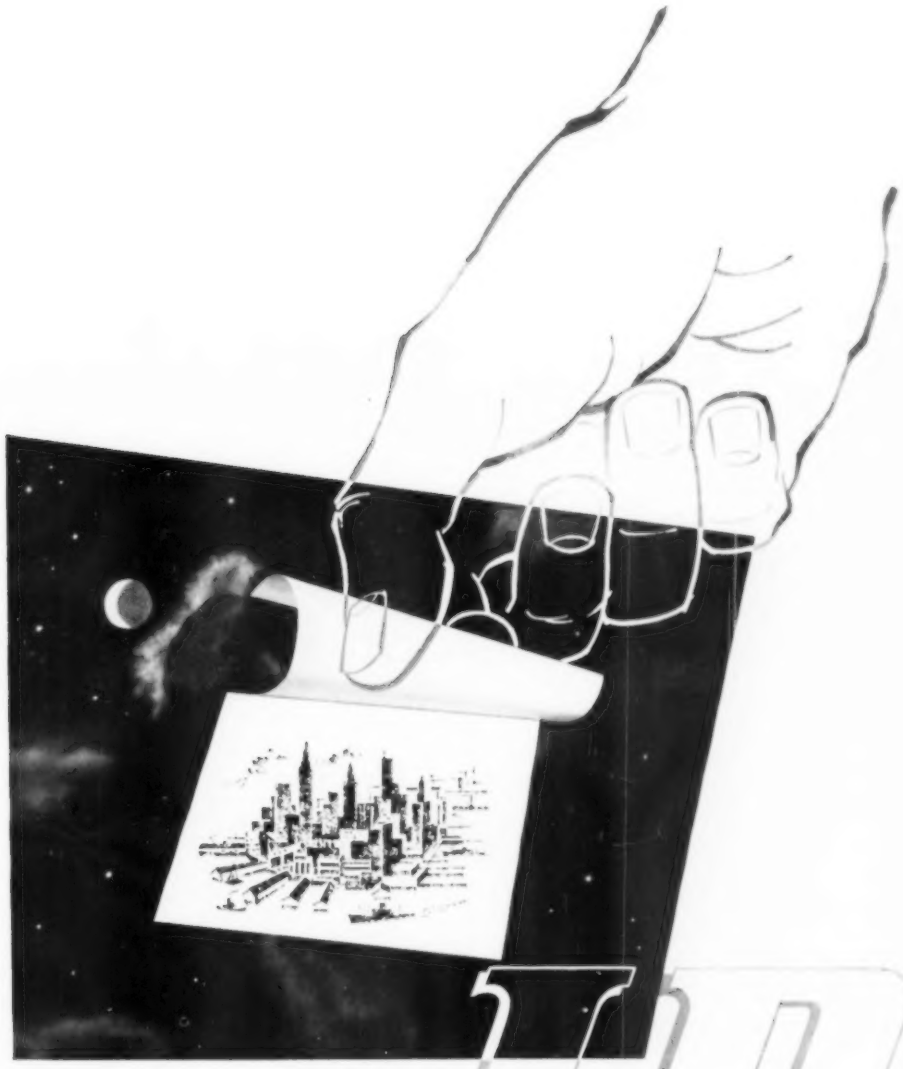
AGRICULTURE: Universal Joints, Propeller Shafts, Axles, Power Take-Offs, Power Take-Off Joints, Clutches, Forgings, Stampings.

MARINE: Universal Joints, Propeller Shafts, Gear Boxes, Forgings, Stampings.

Many of these products manufactured in Canada by Hayes Steel Products Limited, Merritton, Ontario.



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Subject: Your extra membership privilege

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Here are the names and addresses of friends I think should belong to the Ordnance Association. Please send to each person listed, who is not already a member, a membership invitation telling him about the aims, purposes, and services of the A.O.A.

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Additional recommendations may be listed on a separate sheet

Please print your name here so that we may mention your name, and also give you credit for the memberships.

_____ **Your Name**

AMERICAN ORDNANCE ASSOCIATION
Mills Building, Washington 6, D. C.

RAYTHEON SPARROW III

New Navy missile, now with Fleet, guides itself, out-thinks target.

Sparrow III is tenacious, accurate, lightning-fast. It uses a unique "wide-angle" radar target seeker which permits Navy pilots to launch missile from almost any approach angle and still score a hit. Once locked on target, Sparrow III guides itself, flying at several times the speed of sound, and unerringly intercepts the hostile aircraft despite evasive action.

Now operational aboard Navy carriers, Sparrow III is slated for fighter squadrons throughout the Fleet. The missile is designed and produced for extreme reliability; has a powerful warhead and all-weather capability

Raytheon is prime contractor for the Sparrow III, under the Navy's Bureau of Aeronautics. This new missile is another example of how the 37,000 men and women of Raytheon are contributing to national security.

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Waltham, Mass.

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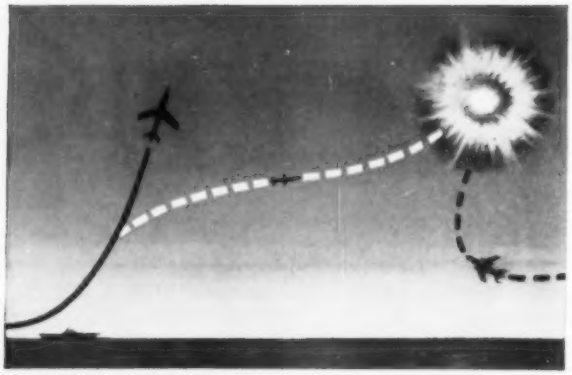

RAYTHEON SPARROW III weapon system employs new "wide-angle" radar. Navy pilot can launch missile from almost any angle and hit the target. Missile guides itself automatically, relentlessly destroys enemy aircraft in spite of evasive tactics.

NOW BEING DELIVERED to the Fleet, Sparrow III arms the latest Navy jet fighters. This new 12-ft. long, 8 inch diameter missile is rocket powered, highly reliable, has all-weather capability. It is extremely accurate and carries a powerful warhead.

Armament Technology

This section of ORDNANCE contains selected papers on armament technology presented at meetings of Technical Divisions and Sections of the American Ordnance Association and contemporary articles on armament research, development, manufacture, and field use

The Antimissile Missile

ARPA research may develop an effective ballistic weapon defense

Dr. Herbert F. York

Chief Scientist, Advanced Research Projects Agency, Department of Defense, Washington, D. C.

THE Department of Defense is making a new approach to the problem of how to handle advance research and development programs by the establishment in February 1958 of the Advanced Research Projects Agency, better known as ARPA.

The first members of the agency began to assemble in late February and early March, and the staffing was practically completed in June. The purpose of ARPA was to carry out, for the Department of Defense, certain advanced research and development programs which had a general Department of Defense interest; that is, they were of interest to more than one of the services.

ARPA was set up first of all as an operating agency distinct from some of the other groups in the Office of the Secretary of Defense which are primarily staff agencies. There are about sixty people in ARPA, divided equally between technical people and management and administrative people. The technical people are in this case all supplied through the Institute of Defense Analysis which is a private, nonprofit corporation—an association of universities formed for the purpose of providing technical assistance to the Department of Defense.

The technical people in the ARPA division of IDA come from industry and from universities and other nonprofit institutions. Some of them are permanent; others are people who have been borrowed for a year or so from their parent industrial or institutional organization because of some particular skill they possess which bears on the programs assigned.

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As to our methods of contracting, we have two choices. We can contract directly with industry or institutions, or we can go through the services, using field agencies of the services for managing our programs. We have, because of our small staff, found it both expedient and useful to follow this second procedure. All ARPA contracts at the present time are managed by one or another of the service agencies in the field.

THE programs that were assigned to ARPA initially were in the fields of space and ballistic missile defense. Originally, the entire national space program was ARPA's responsibility; now this has been limited to those space programs which are of primary military interest.

In addition, we were assigned the job of carrying on advanced research and development in the field of ballistic missile defense (the antimissile field), and we also were assigned the job of making other recommendations to the Secretary of Defense for work to be carried on by ARPA in such other fields as may be pertinent to our organization.

The one program that has been added under that last aspect of our charter is in the development of solid propellants —not solid-propellant rockets but only the propellants. Starting with the ballistic missile defense program, this program is, at the present time, not our largest in terms of dollar commitments, but it is our largest program in terms of personnel assignments within ARPA. That is, just about an even half of all the ARPA people are working on ballistic missile defense.

I MENTION this because it frequently has been mistakenly assumed that ARPA is the Department of Defense's space agency. It is true that at the present time ARPA does manage all the Department of Defense space programs, but the bulk of the work in ARPA is not in the space field but in other programs. I am sure this is the way it will be maintained in the future.

The best way to give a picture of what we are trying to do in the ballistic defense field is to delineate the problem briefly and describe the approaches that the Defense Department is making toward solving it. The problem of interception and destruction of ballistic missiles before they strike their targets in this country is, in its technical aspects, one of the most difficult and fantastic requirements that has been placed on military technology.

To give you a picture of what the problem is, a ballistic missile warhead approaching this country would be traveling about five miles a second, which is about twenty-five times the speed of sound and, therefore, about twenty-five times as fast as a Mach I bomber might approach. So the time which one has to take any action is obviously very short.

If you are able to detect it, just for example, 300 miles out, that means that you have on the order of 60 seconds in which to determine, first of all, that there is a threat, compute the trajectory of the incoming object, make the necessary decisions to take action, and then send an interceptor up, make the interception and destroy the target. Sixty seconds is obviously an extremely short time in which to perform all these functions.

If you can detect the missile 600 miles out, you have twice as long as before. Two minutes gives you an extra minute to relax if you learn how to do it in one minute!

Another problem is the size of the ballistic missile warhead. Airplanes, bombers—the kind of weapons our defense system has been designed against in the past—are relatively large vehicles; that is, they have sizes that are typified by dimensions of 100 feet. Their large size can act as a radar reflector or as a reflector of some other kind of signal to indicate their approach. Ballistic warheads have dimensions measured in terms of feet. The areas involved are thus ten to one hundred to even more times smaller than the dimensions of an airplane. So the detection problem is made doubly difficult by this factor of size.

A third factor is one of discrimination. You may remember seeing in a magazine last summer some pictures that were taken in connection with the Army's Jupiter program in which a nose cone reentered the atmosphere and was photographed on reentry. These pictures showed not just one object coming in but, in this particular case, three—the nose cone itself plus two parts of the vehicle that had been used to propel it into space. Of the three approaching objects, the nose cone, the one you would want to destroy, was the least obvious and most difficult to see.

This means, then, that instead of detecting the warhead when it comes in, you also detect these other things that come with it. If the empty booster is either accidentally or deliberately broken into many small pieces, then instead of three there may be tens or hundreds of such objects entering all at once. Obviously enough, decoys could be deliberately added to make the situation worse.

So the problem of discrimination and of finding out which one of many objects is the warhead is another one of the major problems.

A FOURTH item which makes the problem even more difficult is that of the toughness of the incoming target. Of course, to know exactly how tough it is, you would have to know exactly how the enemy had designed it, but it probably would consist of a target very much tougher than an airplane.

An airplane has large aerodynamic surfaces; it has control surfaces, wings and tail and so forth, which modest overpressures can destroy or break off. On the other hand, a ballistic missile nose cone, such as has been seen in connection with the recovery program, is a neat, trim object, with no major projections to break off. So, the warhead is, on top of everything else, probably also tougher to destroy, and it is necessary to make a closer hit than would be the case with past and present aircraft.

To answer this problem—to try to find a solution to the question of how to defend against ballistic missiles and to make an active defense against them —the Department of Defense has instituted a 2-pronged effort. The first prong is represented by programs within the services which attempt to make use of existing state of the art or of things which we are confident will soon become existing state of the art in order to develop a system which can, we hope, make a successful interception of the first versions of the enemy threat.

One principal component of this program is the Nike-Zeus system of the Army, which consists in outline of a set of radars to detect an incoming missile, devices which compute its trajectory and attempt to determine from the radar data which one is the warhead, and a rocket to go up and perform the interception.

THE other major component of this program is the ballistic missile early warning system, which is an Air Force effort to detect in the northerly regions the nose cones half way on their journey from the launch point to the target, giving us, in this case, a warning of something like ten or fifteen minutes.

These two programs are going ahead, attempting to make use of the present or immediate future state of the art to develop a system which should work against early versions of the threat.

The other prong of the Department of Defense approach to missile defense is the ARPA program whose basic purpose is to do the research and development necessary to supply the technological foundation on which to build a ballistic missile defense for use against the next generation of ballistic missile attack.

We can divide the ARPA program into a number of subparts. First of all, one large part of it has to do with advancing the state of the art by making

further developments in radars and giving them a finer resolution in space or velocity; by attempts to improve power tubes and develop higher frequencies in so far as they may be useful; by developing further computer components and new computational methods to make use of the data acquired; by devising new missiles or new subcomponents of missiles to make interception quicker and more certain.

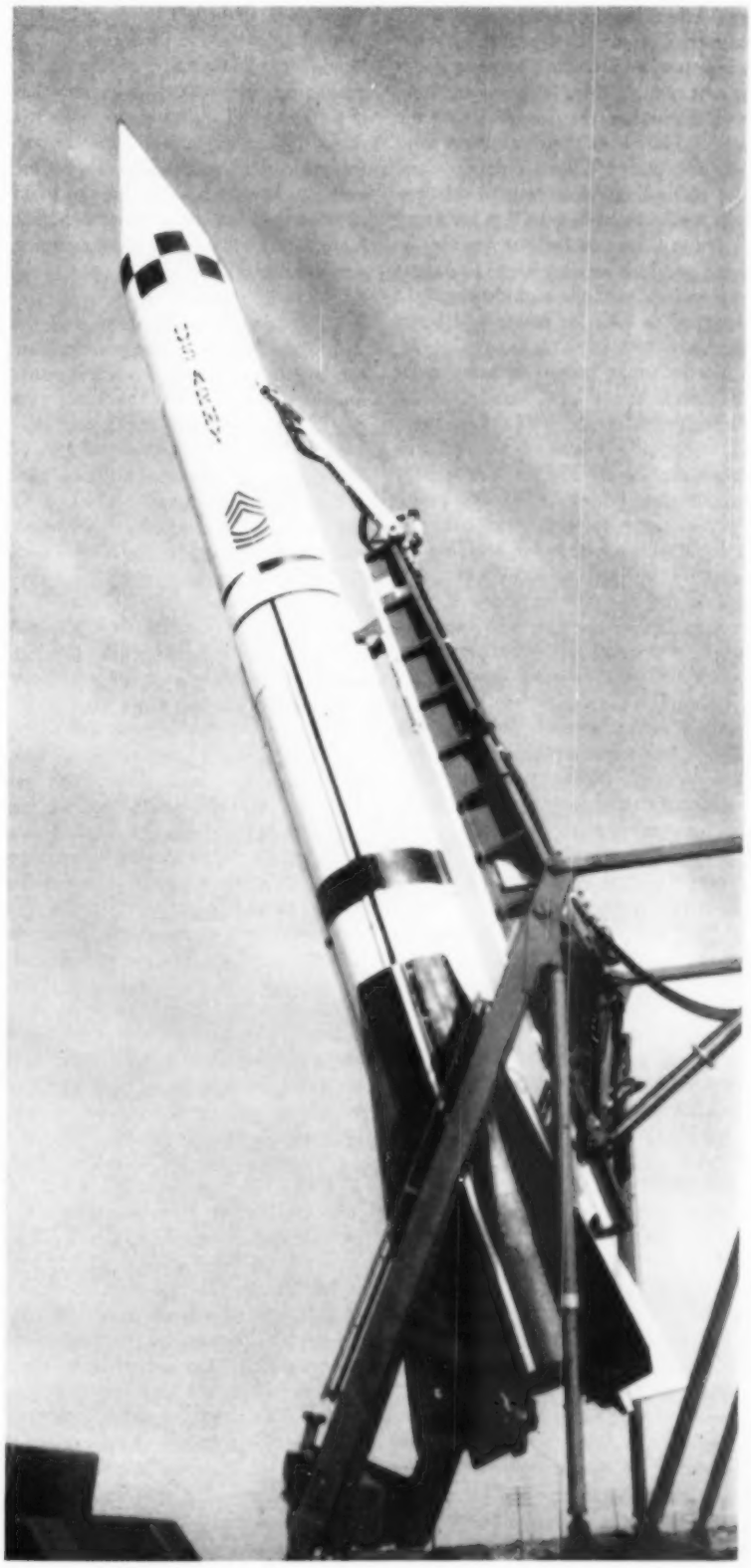
Thus one part of the ARPA program consists of trying to push further development and advance the state of the art of each of the components which form basic parts of the system and which probably, but not necessarily, will form a basic part of future systems.

A second part of the ARPA program in ballistic missile defense is to conduct certain basic research on the phenomena which take place during the flight of ballistic missiles. This is research which we hope will lead to the discovery of information we can use to our advantage later in trying to build and design a defense system.

THIS includes such matters, for example, as the interaction of the ballistic missile nose cone with the upper atmosphere. At the very high velocities involved (Mach 25), when the nose cone impinges on the atmosphere very strong shock waves are sent out. These shock waves are so strong that the air is very highly heated.

This heating of the nose cone on its way in is a problem that the designer of the cone also has to face. But here we want to use it to our advantage: the shock waves produce high temperatures, the high temperatures produce ionization, and the ionization can help the defense since it will reflect radar. Thus it provides something else to observe besides the target itself, and we are studying just what the missile nose cone does on reentry. What else does it do to the air that we can use? Presumably we also will get optical signals, probably signals in infrared, and possibly passive radio signals as well. We have several programs designed to learn more about these interactions.

Similarly, while there is a great deal known already, there is more to be done on the question of what are the weap-



The 30-foot Sergeant ballistic missile is invulnerable to any present means of countermeasures (Army photo).

ons' effects of interest in connection with the interception problem. What happens when an atomic bomb explodes at a very high altitude near something else? How does the one react with the other? How does the destruction actually take place? What are the possibilities of finding other new phenomena that would be of help in this problem?

Thirdly, in our ballistic missile defense program we also have in progress exploratory research and development designed to look for newer and better methods.

For example, instead of using radar to detect, one might consider using, somehow, infrared. We have an interesting possibility here in the fact that on take-off the rocket produces a large amount of infrared. Observing this from satellites, for example, would provide us with a means for doubling the warning time presently available.

Looking into other methods of interception besides the use of rockets with atomic warheads is something else which we are doing and trying to encourage. This includes the use of some kind of ray or beam or what have you. This may seem a little exotic, but, nevertheless, it does seem to be worth looking into and may have some possible future use.

In the solid-propellant field we are sponsoring basic research—not a program in the development of solid-propellant rockets. There are already, in this country, numerous large programs in the development of such rockets. They are in all the services—the Minute Man, the Pershing, the Polaris, and so on. We, instead, are sponsoring a smaller program in the development of solid propellants *per se*.

HERE, again, one might describe this as a program designed to produce the technology on which to build the next generation of solid-propellant rockets—or the one after next. In this program, the primary emphasis is on basic chemistry, synthetic chemistry—trying to identify new possible compounds, trying to learn how to make them, doing the necessary thermochemistry, physical chemistry, and so on—to discover the potential, the specific impulse, the temperatures, etc., of these new propellants.

There are programs designed to learn more about the burning process that takes place when a solid propellant is fired. Also, there are programs on materials in connection with nozzles, packaging, and so on. It is obvious that if we are going to be able to make use of a higher-temperature, higher-performance solid propellant, we also are going to have to find out how to build nozzles that can withstand the higher temperatures that go with the higher performance.

OUR third major program and the one which is at the present time the largest budgetwise is what is rather loosely referred to as "the space program." This, as I have said, originally consisted, for about a period of four or five months, of the total national space program. This program subsequently has been divided into two parts, a civil space program under the direction of NASA, and certain military space programs under the direction of ARPA. The ARPA programs can be subdivided further into two parts—vehicle development and military applications of our newly achieved space-flight capability.

In vehicle development especially, but in other areas too, the ARPA program (*i.e.*, the Department of Defense program) and the NASA program are very closely coordinated.

There are under development three major advances in boosters, two in the million-pound-thrust class, one involving the development of a large single chamber, and a million- or million-and-a-half-pound cluster. The former is under the direction of the NASA.

In addition to these two large thrust engines, there is also the development of a high-energy liquid upper stage which uses liquids having a considerably higher specific impulse than the kerosene-oxygen combination. This high-energy upper stage is for use as an additional stage to be used atop the ICBM boosters now being developed as a part of the missile program.

Incidentally, in this connection one cannot overestimate the very great importance of the enormous contributions the missile program makes to the space program. I am not sure that it is generally appreciated.

In addition to the development of boosters we also have the development of the space vehicle itself. In the case of our first satellites—that launched by the Explorer and the one small satellite launched by the Vanguard—the space vehicle was a simple object because the objective was merely to get it into orbit with some instruments aboard and let the orbit be what it might. We didn't worry about orientation or other similar factors concerning the space vehicle. The power requirements were very modest.

As we get into more sophisticated applications of satellites and other space vehicles it will be necessary that the vehicle itself be something much more sophisticated than simply a spinning can, as was the case in the early satellites. It will be necessary to have satellites whose orientation can be controlled in advance, or perhaps determined after it is in orbit, with respect to the center of the earth or to inertial space; that is, oriented with respect to the stars. It is a difficult problem to learn both how to tell what the orientation is (how to tell which way is "down") and also to achieve the orientation after you determine what it should be.

IN addition we will have to develop stabilization so that once the vehicle is oriented it will stay the way we want it for a given period of time and does not oscillate around some predetermined orientation but stays fixed at some particular one. We have to develop better power supplies for supplying electricity for operating various kinds of apparatus—perhaps supplying some additional rocket power for making various kinds of correcting maneuvers, and for providing the mechanism for orientation.

In future programs we also will want to have satellites which can successfully reenter the earth's atmosphere, pass through it without being damaged, and land on the ground in such a fashion and place that they are recoverable. These are all things which we will have to do in the way of developing better satellite vehicles themselves as distinct from the boosters.

Carrying out a program of this sort will require that a considerable number of satellite flights be made for the sole purpose of developing the satellite vehicle itself rather than for some other application, such as making measurements, providing communications relay, or performing reconnaissance.

Anyone who is familiar with aircraft or missile development knows that it

requires a great many flights just to develop the vehicle itself before it can begin to be used for some specific application. In this connection we have a sort of interesting security problem in reverse because when we disclose the purpose of the flight, people just are not going to believe it. Thus if we say it is merely for the purpose of developing a satellite vehicle, it will be taken as a sign that it has some more sinister purpose. Otherwise, why would we deny that it did?

Anyway, we will have flights in the future, many flights, which are simply for the purpose of developing the vehicle, both the booster and the satellite *per se*, for future use in various applications.

There is also another program which I think falls properly under the heading of vehicle development or space capability, and that is the man in space program, now under the direction of NASA. It is a program in which we are maintaining very great interest and are providing some consultation with regard to technique and component developments and so on.

In addition to vehicle development we also have an active program in the practical applications of space vehicles. One of great interest is, for example, the communications relay satellite. It has been suggested frequently in the past, and many proposals have been made by industry and the services as to how to use communication satellites for relays.

The possibilities here really look very promising in terms of signal-to-noise ratio which ultimately determines the principal things that can be done. It appears that ultimately a satellite with just a few watts of radio power can relay hundreds of voice messages simultaneously.

THERE are several different versions of this type of satellite. The military interest is primarily in what are called the "active" versions. NASA also has programs concerning what are called "passive" satellites. These latter are reflectors in space, off which radio beams are bounced.

The active satellite is of two types. One is a low-flying satellite which contains a tape recorder. Messages are sent up to the satellite and stored on the tape recorder. Then as the satellite passes over some other point on the earth, the people on the ground, by means of a coded electronic key, can cause the satellite to disgorge its information, delivering it to the remote point. This is called the delayed active relay.

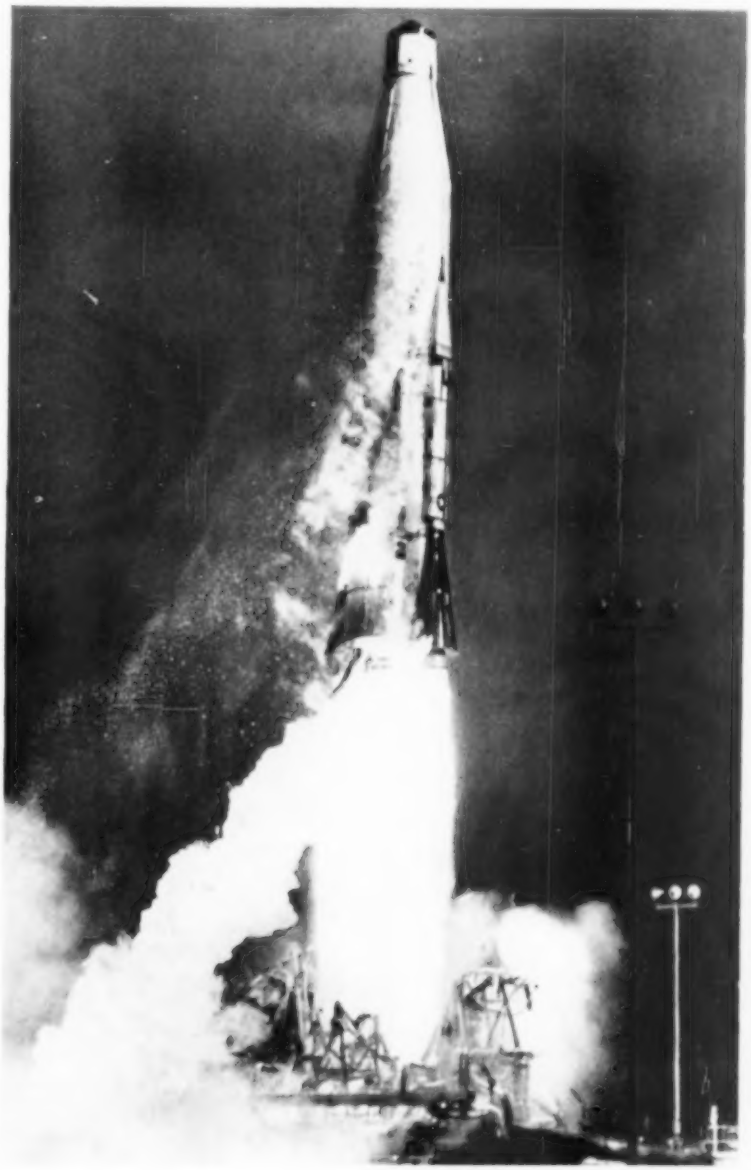
The other type of active relay is one in which the satellite flies at a very high altitude. Messages can be beamed to it by a directed antenna on the ground. The satellite then receives them, amplifies them, and broadcasts them back to the earth by means of a directed antenna so that the radio energy is not wasted in space but beamed downward either to the whole earth or, in more sophisticated future versions, to some particular narrow point on the earth.

The satellite relay system has the advantages of providing, potentially, a very large number of channels with a high degree of reliability and flexibility.

There are, of course, many other important military applications of space flight which I do not have time to discuss here.

We should start considering each of the applications and the possibility of other ways of doing the same thing.

Kerosene-type fuel and liquid oxygen lift seven-story Atlas ICBM in recent test.



Our Defense Potential

If we do not provide for basic research in the design of our new major programs the consequence is likely to be loss of time, an increase in the over-all cost, and inferior military equipment

Dr. Louis T. E. Thompson

SOME of the difficulties the services have in convincing others that they need support for certain kinds of research or other work in the development program may stem from misunderstandings in the meanings of words. A word that impresses me most because of its implications is "potential."

In looking at some of the problems which have to do with the development and use of ordnance, the meaning of the word "potential" or "potentials" goes well beyond the potentials of the physical sciences. An example can be seen in the extreme importance of having clear thinking about the operational environment of the prospective combat situations that one has to deal with in long-range studies about programs for the development of new strength.

THIS question goes well over into areas that are not very close to those we normally think of as supporting foundations for development work. If our potentials are not good in some of these adjacent areas, such as those which have to do with environments in areas where conflict may develop; if our understanding of the uses which are likely to develop is poor—whether in political or economic potentials or those having to do with cultural developments—there is a very high probability that we will not realize the full potentials that are available to us in the technological areas.

Perhaps the best way to get acquainted with the problems that confront programs in the areas of research and development is to examine the experience and the operations that are going on successfully in some of these areas. It is important for a program to have good relations with the outside world, such as the Los Alamos facility which has involved so many couplings with university and industrial groups as well as with the military establishment.

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After hearing discussions of the problems of the military establishment in getting its foundations for armament development in the best possible shape and by reading the reports and papers that are available to the public and the Department of Defense, we must conclude that what we are concerned with is something that, while not easy to define, does measure a degree of uncertainty about the success we are having in these efforts to build our strength to maximum values.

There is a general feeling that we must now do something that is effective to improve the health of the whole development cycle which begins with exploratory work of one kind or another. It may be fundamental, pure research, or it may be applied research, or it may have to do with development work itself or with the transitions to test design and, of course, production.

There is something about this cycle that is not as good as we would like to have it. I have been interested in looking at the evidence that is available regarding the history of the technologies we are concerned with from this point of view. It is a comparatively new situation that now confronts us.

UNTIL perhaps thirty years ago, the pathways to new equipment and new devices for peacetime living or wartime fighting came almost invariably from cycles in which the technology itself was the dominant factor. What came after that frequently was an incentive—a stimulation for some kind of research.

This was particularly true prior to the last century. Within the last thirty or forty years we have seen a complete reversal of this cycle. It is no longer practicable to start with an idea and proceed immediately with the inventing process. At least, not in the case of most of our major systems work. This change, this rearrangement in the characteristics of the development cycle and its philosophy, is causing some confusion.

In the design of our major programs we often are inclined to feel as inventors felt a few generations ago—that with a good idea and a sound background the best way to expedite the program was to go immediately into the specifications for hardware; that is, for equipment in the systems sense.

This procedure does not work well now. It cannot work, actually, in any important sense in the future. The requirements for putting together the large number of component studies that have to be made in new systems work are so severe that any attempt to short-circuit this first phase of the cycle, as part of the development is concerned with explorations of one kind or another, ultimately will retard the whole project.

IF we do not provide for such studies in the design of our new major programs, the consequence is likely to be a loss of time, an increase in over-all cost, and, perhaps even more serious, less than best results as the effort is translated into some kind of equipment.

We are witnessing a kind of anomaly in respect to this philosophy. We note our confusion when we try to make choices. We try to pick out something to do that looks best. As our rapidly increasing background of knowledge develops further, this confusion will be greater unless we are able to focus our attention on the proper use of exploratory tools—the tools for careful selection of a few best channels through which to develop our programs toward some general operational objective.

The consequence of not following the latter procedure is likely to be an increasingly large number of matériel programs with sequences unacceptably prolonged in proceeding from what represents the state of the art when the alternative hardware designs are identified with the final result. There will be a tendency to produce obsolescent matériel.

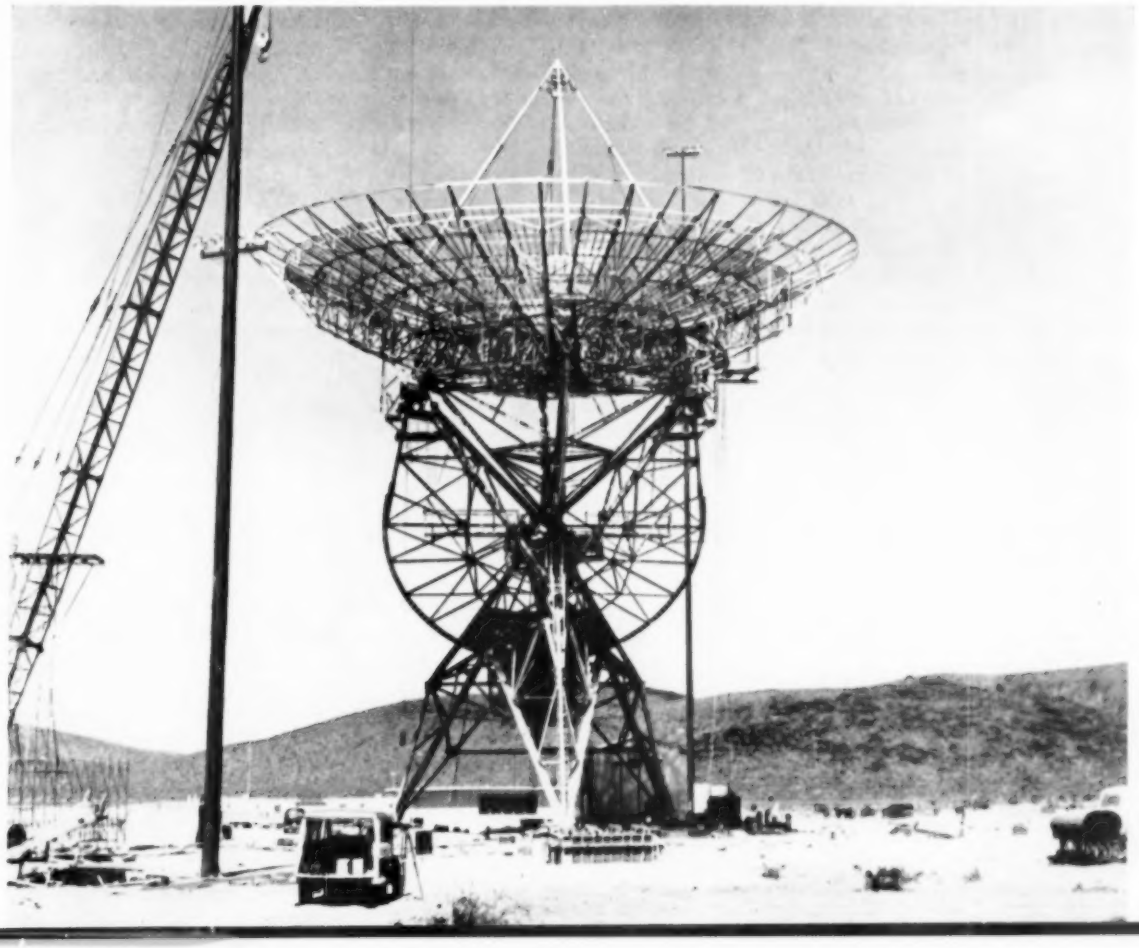
The difficulties of the kind I am referring to are evident in our present programs to some extent. If there is one way in which we could make great progress toward improvement in the effectiveness of our development cycles, it would be to use exploratory techniques more effectively for the final selection of a few choices. The specifications for matériel can well be postponed until the component work is about ready for translation into system items.

If, somehow, the contract procedures could be modified to permit this 2-phase approach to our development objectives, we should receive great returns in reduction in cost and improvements in the effectiveness of our final items.

The anomaly I referred to deals with the interesting comparison of our present predicaments—which result from the ever-increasing flow of new knowledge and new information which in turn stimulates new thinking—with the corresponding evidence that we find everywhere that we must have *more* research.

WHEN I refer to the additional effort in this direction, I am referring primarily to the requirement that we ensure that our scientific and military health five, ten, or fifteen years from now is as good as it can be with the talent we have available. I refer to the paralleling of applied research of the kind that has been mentioned as state of the art work which is necessary en route to matériel objectives during this period prior to the definition of matériel characteristics.

With a present range of 400,000 miles, this giant satellite-tracking antenna at Goldstone Lake, Calif., will be able to receive radio signals from space at ranges of 4,000,000,000 miles when fully operational (Army photo).



Armament Progress

The military services and defense industry are jointly engaged in creating a new program for fundamental scientific research in this country without serious disruption of the classical support pattern

Dr. Louis N. Ridenour

NOT only is industry increasingly dependent on fundamental research, but so are the military services and the defense community as a whole. It is clear that practical technology rests on a base of fundamental research and, in a world where the West cannot afford to compete man for man, it is equally clear that advanced technology must be the main bulwark of our defense posture.

The dependence of modern defense and warfare on basic and applied research is thus intimate and immediate to a degree which hardly could have been imagined even as recently as the beginning of World War II. Most impressive, of course, has been the replacement of chemical explosives by nuclear weapons about a million times as effective on a pound-for-pound basis. But advances almost as dramatic have been achieved in other areas of military technology.

THERE are aircraft in the present U. S. inventory which can fly at more than twice the speed of sound. The power and subtlety of electronic devices for guidance and control have advanced to the point where we can design and build rather sophisticated unmanned missiles. Earlier members of this genus are operational today, and a new, more powerful, generation of missiles is currently in the development flight-test stage.

These and other weapons and military devices have greatly altered the probable nature of future large-scale armed conflict. While trying to assimilate and adapt to the progress already made, the military services have simultaneously been adding their weight to efforts to shorten the time between the acquisition of new scientific knowledge and the realization of new practical devices and techniques based on that knowledge.

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Both industry and the military have been doing this for a long time, so that the present situation is really quantitatively, rather than qualitatively, new, as far as development goes. In respect to the support of fundamental research itself, however, the relatively heavy participation of defense agencies and of certain segments of industry is qualitatively new.

Scientific research in the modern sense is itself rather new, having really commenced only about three and a half centuries ago. The influence of science on industry was negligible until about a century ago, when organic chemistry began to have practical implications and the electrical power and communications industries were born.

The really large scale interaction between fundamental science and practical affairs, including industry and warfare, has taken place only during the last generation. It is therefore not particularly surprising that we have been, and are still, in a period of rapid adjustment with respect to the support of fundamental scientific work by industry and by the military.

Everyone has his own definition of what constitutes fundamental research. Perhaps the easiest definition to understand is one that relates to motivation: "Fundamental research is the search for improved knowledge and understanding without immediate regard to the material and economic advances which may result therefrom."

THIS distinguishes fundamental research from applied research and engineering, which are always directed to the solution of practical problems defined at the outset.

Note that I said "without *immediate* regard to . . . advances." The qualifying adjective is important in the present context. If there were not a strong and complete conviction that immense practical results flow from a sound program of fundamental research, there would be no justification for industry and the military to support work of this sort.

As we all know, there is overwhelming evidence that technical advance has its roots in fundamental scientific progress. There is even rather good evidence that a given practical goal is best sought by not looking for it too directly.

Who would have imagined in 1932 that the pioneers of modern nuclear

physics were in fact engaged in enhancing the energy content of explosives? Who, charged with that technical responsibility—improving explosives—would then have undertaken his task by investigating artificial nuclear disintegration and radioactivity?

The idea that enormous practical consequences attend all soundly conceived and successful fundamental research is now well established. The idea is well sold in many important segments of industry, particularly in those industries owing their birth and very existence to past advances made by fundamental scientific workers.

IT is thus no accident that Bell Telephone Laboratories, the General Electric Research Laboratory, and the research laboratories of Westinghouse, Du Pont, Eastman Kodak, and other industrial concerns born of science are the Nation's leaders in fundamental research supported by industry out of profits, and in anticipation of future profits.

The wisdom of this course has been demonstrated repeatedly. Perhaps the most impressive recent demonstration was the opening up of the new field of solid-state electronics through the invention of the transistor by Bardeen, Brattain, and Shockley at Bell Laboratories a decade ago.

Industries having a predominantly civilian market more readily can afford the expense and the risks of a stably supported research effort, since their profit margins are generally high compared with those of defense industry. Yet defense industry plays a very important role in our current economy since direct defense expenditures approximate a tenth of the gross national product.

Generally speaking, defense work is carried out by industry under a contract system which not only limits profits to low values compared with those usual in civilian business but also has rules which disallow costs in certain categories ordinarily regarded as normal business expenses. This makes it difficult for defense industry to finance any substantial program of fundamental research out of profits.

There is another difference between civilian and defense industry, as far as their ability to support fundamental research is concerned, which also relates to profits. Fundamental research is usually characterized by rather vague initial definitions of problems, by dubious chances of achieving important results, and by lengthy programs which are difficult or impossible to schedule.

This makes it a risk venture for the industry which supports a fundamental research program, yet the pay-off from an important proprietary advance can be so substantial that civilian industry is willing to take the risk in anticipation of the large but legitimate return that it may bring. In the case of defense industry, the military customer is not likely to allow the rewards that must be associated with the risk.

It is therefore fortunate for all concerned that the Department of Defense is making it possible for defense industry to contribute to the total national effort in fundamental research. This is accomplished principally by two devices: direct research contracts and a policy of allowing research as a component of indirect cost. These policies, together with the substantial amount of fundamental research carried out by the military services in their own technical establishments, make the Department of Defense the largest single patron of the sciences in history. To carry out this role effectively, all concerned must understand and appreciate the special nature and peculiar requirements of fundamental research.

First and most important, it must be appreciated that the greatest advances in fundamental science are almost always traceable to the work of a single exceptional individual. There is no substitute for talent. Neither two men or ten of lesser abilities can be expected to achieve what can be accomplished by a superior individual.

WHILE this is not always explicitly recognized, and the promise of a research effort is often related to its budget and its population, a very brief examination of the past is sufficient to emphasize the overwhelming importance of individual quality.

Another requirement for success in research is consistency of support. Most programs of fundamental research do not involve large levels of expenditure, at least in the terms which are becoming familiar to the Department of Defense, but success almost always depends upon the continuous provision of funds for a stable level of effort during the period in which the research program can profitably be pursued.

Technician utilizes a mass ray spectrograph in the development of boron-based, high-energy fuels.

A relatively small stable program is likely to yield much better results in absolute terms—and tremendously greater value per dollar expended—than will a program involving much more money spent in stop-and-go fashion.

NOT only is continuity of financial support required, but consistency in the manning of a fundamental research effort also is very desirable. In defense industry, there often are emergencies in military development programs which appear to demand the assignment to the task of every available individual, and these recurrent "flaps" are frequently permitted to disturb the assignment of senior technical people to programs of fundamental research.

Of course, doing the main job successfully is of primary importance, but both the research director and the military customer should recognize clearly the immense importance of the long-range fundamental work, as well as that of the more immediate work on weapons development.

Finally, I should like to mention a rather surprising requirement for successful industrial prosecution of fundamental research. Before being connected with research in industry, I would not have guessed that this requirement existed. I refer to the keen desire of the industrial research worker to see practical applications made of the advances in knowledge to which he has contributed.

This is a bit of a contradiction. We defined fundamental research as work undertaken without immediate regard to application. Now I am asserting that vigorous attention to applying the results of fundamental research is an important factor in mounting and sustaining a successful and effective research program. And so I believe it to be.

While the research scientist cherishes his "ivory tower" in the sense that he wants proper working conditions and freedom from day-to-day demands on his purposes and efforts, at the same time he is aware that he is part of a technical industry and he desires to contribute to the advancement of that industry. The industrial research laboratory should never be too far out of the main stream of progress in the industry supporting it and which it supports.

Let us now examine the ways in which the Department of Defense and its constituent military departments support fundamental research, with especial attention to research performed in industry. First of all, it should be understood clearly that the large and expensive programs of "research and development" on new weapons and weapons systems have nothing much to do with the topic we are discussing here.

They are, for the most part, programs of development engineering and development test which draw upon, but do not contribute to, the body of scientific knowledge made available through fundamental research.

Recognizing this, the Department of Defense has adopted procurement policies which permit industrial contractors to include as a component of overhead expense on research and development contracts the costs of a program of fundamental research. This single device probably has done more than any other to advance and broaden our total national capability in fundamental research, and it is to be hoped that its exploitation will grow.

Highly sensitive X-ray devices determine the crystal structure in developmental research of heat-resistant materials (Battelle Institute photo).

THE statutory limit on expenditure of this sort is, in the current armed service procurement regulations, six per cent of the direct costs of the research and development programs. I am not aware of any contractor who has been fortunate enough to receive a proposal of expenditures at this level. They normally run from one half to perhaps one and a half per cent, which is low in comparison with the research expenditures of private industry as deeply rooted in technology as defense.

All of us should strive to increase the use of this completely legal, completely authorized, very useful and not-well-enough-used device to increase the total national capability in fundamental research.

Unfortunately, it is sometimes true that contracting officers and Government accounting agencies are not particularly friendly to technical activities which do not make immediate and visible contributions to advancing weapons technology. This is an old problem. More than twenty years ago I visited my friend Joe Kaplan, then as now a professor of physics at U.C.L.A. He was working on the elucidation of the band spectrum of the nitrogen mole-

cule, to which effort he has made major contributions.

"Of course," he said to me when I visited him, "whenever a member of the California Legislature comes through my laboratory I tell him I'm trying to make better fertilizer."

Now there is nitrogen in fertilizer, and knowledge is power, but Joe was clearly engaging in the kind of scientific statesmanship that is so essential when public funds are involved.

In addition to the fundamental research supported as an indirect cost under military research and development contracts, the Department of Defense makes direct contracts with universities and with industry for basic and applied research not specifically connected with the development of weapons systems.

The funds available for this type of work are relatively small and must be divided among the in-house laboratories maintained by the military services, the colleges, universities and nonprofit research institutions of the country, and industry. I think it is fair to say that industrial laboratories come off a poor third in this competition.

The requirement for sustaining the service laboratories is obvious and immediate. The universities offer distinguished technical staffs and, generally speaking, relatively low overhead expense. Industry has many sources of support for its work and is sometimes regarded as competing unfairly when it seeks direct research contracts from the military services.

THIS is a shortsighted approach to the problem, in my view. While it is undeniably true that the accounting methods which industrial concerns must use appear to yield higher costs per man-hour than are typical in universities, nonprofit institutions, or Government laboratories, we have already noted that the *return* per man-hour is critically dependent on the quality of the man or men involved.

Provided that an industrial laboratory has individuals who can make outstanding contributions to a program of research, it should be considered on an equal basis with all other competitors for contracts calling for research not immediately oriented toward the development and improvement of weapons.

Possibly this is the place to say a word about the "requirements" concept as an approach to the development of weapons and weapons systems. It is sound to let men of deep operational experience take part in the genesis and the early development of new weapons; it is a mistake to let the whole program of technical work be shaped by them.

While it is seldom admitted, the current state of the technical art is more responsible for the current military "requirements" than is the nature of warfare and the necessities of its prosecution.

TO oversimplify: An honest but simple-minded man charged with the task of setting forth requirements for the Army might specify a need for a portable death-ray machine, easily carried and aimed, requiring no maintenance, and effective out to great ranges. But he would never do so, however simple-minded he might be. He would modify this ideal with his own ideas of what might possibly be achieved.

Thus military requirements are compromises, even though often they are not recognized as such. They are compromises between the ideal and the supposedly attainable. To permit the present structure of existing requirements to limit or restrict or alter the nature of military research programs is a serious mistake for, by definition, research is devoted to finding out what we do not know and enabling us to do what we cannot now do. It is thus unlikely that we shall have enunciated a requirement for the new knowledge that research can bring us.

There is an unfortunate tendency in some parts of the military to reject fundamental research programs because of the fact that they do not appear to be directed at any existing military requirement.

This should be avoided. Research proposals should be evaluated only on the basis of the competence of the proposed investigators and on the pertinence of the general technical field to the military job. No useful results may be attained, and frequently none are. But progress will be made only if the military has the courage and the vision to tackle the unknown.

The great importance of continuity and consistency in the support of research already has been mentioned. Defense research programs have, in general, fluctuated more than is desirable in their level of activity and support. In part this reflects the annual fluctuations in funding imposed on the Department of Defense by Congress and by the Bureau of the Budget.

There appears to have been a tendency, however, to pass on to the research effort the main brunt of the problem of meeting declines in military funding. When times are hard, the forces in being are the last to suffer, procurement programs come next, and research and development efforts are cut roughly in proportion to their distance from practical items.

This is an oversimplification, of course. But many of you know how hard it is to justify the retention of a fundamental research program financed by one of the military services when it is competing for funds with an activity which is making a clear and distinguishable contribution to existing military capability.

Despite this difficulty, we must all continue to press for consistent military support of fundamental scientific research, since the military departments, as already noted, are today the major patrons of science.

DEFENSE industry is doing its part. It already has been suggested that the exigencies of defense contracting are such that major research laboratories cannot be maintained except by firms doing mainly civilian business.

It is true that the going costs of these laboratories are met by direct research contracts from the military services and by overhead charges on military research and development contracts, in some combination. But it is equally true that the brick and mortar in which the work is done and the technical equipment with which the work is done in general have been provided by the military contractor.

Thus it is true that the military services and defense industry are jointly engaged in creating a new pattern of support for fundamental scientific research in this country and in the Western world. This is being accomplished without serious disruption of the classical pattern of research support. The results of this program will yield benefits both to the military and to our peacetime economy.

Idea to Weapon

The conversion of scientific discoveries to practical armament in the shortest possible time is a problem that has engaged the minds of scientific, engineering, and military men for many centuries

Dr. Alexander H. Flax

THE problem of converting scientific discoveries and technological advances into the "hardware" of weapon systems in the shortest possible time is one which has engaged the attention of the military, scientific, and engineering communities for centuries. Among the first so concerned were the Romans and Leonardo da Vinci.

As a nation, we have long excelled in applying the results of scientific discovery to the design and mass production of goods and products.

Jules Verne, as far back as 1866, expressed the view of the rest of the world when he said, "The Yankees, those foremost technicians of the world, are engineers, as the Italians are musicians and the Germans metaphysicists —from birth."

Today, when national survival seems to depend on the timely availability of weapons of the utmost technical intricacy, superior to those of any potential enemy, the national attribute which Verne described is indeed a prerequisite for our continued existence as a first-class power. Nevertheless, recent experiences have shaken our confidence in the adequacy of our weapons-development procedures.

THE successful Russian launching of Sputnik, not only the world's first artificial satellite but one of impressive size and weight in comparison with our own projected satellites, caused searching reexaminations of our military-engineering-scientific organization.

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But Sputnik was only a more spectacular demonstration of what already had been foreshadowed by the rapid and effective Russian development of the atomic and hydrogen bombs, jet airplanes and engines, and long-range ballistic missiles.

The Russians are making a determined bid for first place in technology generally, and in armament technology particularly. It is unnecessary to review here the frenzied public reaction to Sputnik—as a phenomenon it is matched only by the indifference with which the preceding Russian advances were viewed. In any event, it is now almost as clear to the public as to the experts that we are in a weapons research and development race. What is not clear to the public, and what the experts do not agree upon, is just how we are to go about winning and how much we need to pay to accomplish our objective.

In view of our long record of success in putting the discoveries of science to practical use, it is certainly appropriate to inquire whether we should do anything different from what we have done in the past, granting the need for greater concentration on the task. In order to answer this question we must look at what has happened to the entire cycle from basic research to production during the past 150 years, and in particular the American role in research, engineering, and production during this period.

Prior to the nineteenth century there was little in the way of either research or industrial production to be found on this continent, partly because of British legal restraints on the colonies and partly because of the colonists' preoccupation with other matters. The beginning of the nineteenth century saw the beginning of importation of industrial know-how from England and the blossoming of native inventors like Eli Whitney.

FROM these beginnings our ability and reputation for mechanical ingenuity and mass-production techniques reached the heights extolled by Jules Verne as mentioned earlier.

Such science as lay behind these engineering achievements was many centuries old, embodying principles known to Archimedes and Leonardo da Vinci, and the most recent significant contributions, those of Newton, were also a century old.

As the nineteenth century progressed, the tempo of scientific discovery increased, particularly in the field of electricity. On the whole, our contributions to this increased activity in basic science were relatively small, although here and there in this country was to be found a singular genius like Joseph Henry. The giants in electrical research

were Michael Faraday and James Maxwell, both in England.

The theory of electromagnetic waves was put forth by Maxwell in 1864. It was not until 1887 that Hertz ran the experiments that demonstrated physically the existence of the electromagnetic waves called for by Maxwell's theory. From this time to the practical transoceanic wireless telegraph of Marconi was only fourteen years, but it was not until 1936 that the beginning of practical forms of radar, also a direct outgrowth of Maxwell's theory and Hertz's experiments, was attained.

Depending upon where the beginnings of electromagnetic theory are reckoned to lie, a lag of forty to eighty years existed between the accomplishment of an advance in basic research and its application to practice. By contrast, the neutron was discovered in 1932, fission was discovered in 1939, the first chain-reacting pile was brought into action in 1942, and the atomic bomb exploded in 1945. The entire cycle, depending again upon where the beginning is reckoned, took from six to fifteen years.

THE recent discovery, development, and widespread application of the transistor in a very few years offers another example of the steadily decreasing time between basic research and application. It is this factor which probably represents the most important change in the research and development picture in our time.

The marked reduction in the time from basic research to application does make some important differences in the type of military, scientific, industrial relationships necessary for the most rapid utilization of the results of science. In the nineteenth century we could excel industrially with hardly any applicable basic science originating in this country. The long time between discovery and application allowed for a widespread diffusion of the basic knowledge all over the world long before applications were made.

In the first half of the twentieth century the time was sufficient to allow the engineer to absorb such results of basic research as he needed if he made a determined effort. Even today this is still the case in many areas, but increasingly less so.

The development of the atomic bomb, for instance, was carried out with the intense participation of the men (practically all born or educated in Europe) who had done the basic research in the field. To an ever-increasing degree, it seems likely that close ties between the research scientist and the design engineer will be required.

FORTUNATELY, American basic research has come a long way since the nineteenth century. From 1943 to 1956, out of sixty-seven Nobel Prize winners in physics, chemistry, and medicine, thirty-four were American. Incidentally, only one was Russian. Today we can be said to lead the world in basic research, yet the average citizen and even the average engineer is diffident about lending his enthusiasm to the basic research program. When the last Secretary of Defense, as quoted in a congressional committee, directed a squeezing down on basic research because it was an unnecessary luxury, he unfortunately was speaking with the voice of a great majority of our people.

We tend to think of ourselves as practical users of common sense, not realizing how much common sense is the result of basic discoveries in the remote past, as William James has so aptly put it. Nevertheless, basic research has flourished in this country; the problems before us in this area are largely those of continuing the progress at a rate comparable to the growing need and of seeing what can be done to make the results of basic research available more quickly to the user.

Before a scientific advance can be translated into production, there is usually a stage of applied research and development. This is not invariably the case, nor is it true that all practical devices must have their origins in basic research. It can be argued, however, that to an increasing degree the more significant new weapons do have their origins in basic research and must go through the stages of applied research and development. It is in the area of applied research and development that the weakness of our procedures for procuring military weapon systems becomes apparent.

"Today we can be said to lead the world in basic research, yet the average citizen is diffident about lending his enthusiasm to the basic research program."

The increasing complexity of devices and experimental test facilities has raised the cost of applied research and development to fantastic new heights, and there is nothing to indicate that these costs will not go even higher. This being so, it is extremely difficult to obtain funds for speculative applied research and exploratory development in areas just opened up by basic discoveries, or by the realization of new implications of older discoveries, unless these can be related to a specific military weapon system which can be formulated in terms of fulfilling a military requirement.

Unfortunately, this set of conditions is not often met. There was no specific military requirement for the airplane, the jet engine, or the atomic bomb, since it was not at all clear that such things were feasible. Further, early-stage applied research usually is applicable to more than one end product, and identification with one or another specific weapon system may be rather artificial.

Unfortunately, the same suspicion which we as a nation attach to the virtue of basic research also extends to early-stage applied research and development where no specific end product is in view.

AS has been noted, basic research has flourished in spite of a lack of popular support, but since applied research usually is more expensive, it cannot flourish in the absence of substantial popular support. In a complex of active civilian industry doing research with the expectation of production and profits, and a military program aimed at specific weapons, we have thus far managed to do sufficient applied research and development to keep up with our needs. We probably have not done this in the optimum way at a minimum cost or in the minimum time.

For instance, many components and subsystems common to several weapon systems are often developed independently by the various weapon systems teams. While this is not necessarily bad in all cases, it is certainly wasteful in some cases. Further, initiation of much applied research and component de-

velopment is delayed until some specific weapon system is funded. Often we have done the right applied research without really knowing why we were doing it.

For example, the Navaho missile program, now defunct, provided important applied research, often of a more or less general nature, in the fields of large liquid rockets, inertial and other forms of guidance, and supersonic aerodynamics. This work has been of the greatest importance to many current programs, particularly the ballistic missile programs, now on a "crash" basis.

IT is expecting too much to hope that even the best-planned program will always do all the right applied research, but it is clear that there are important areas where applied research is needed—research which must be accommodated outside the framework of presently planned weapon systems. This is an activity in which we are currently highly deficient and seem likely to become more so.

The changing pattern of national strategy and consequent military force and the changes in weapon requirements also can wreak havoc on the research and development program and have done so on several occasions. In just the past decade we have seen our national strategy go from "containment" to "massive retaliation" to "deterrence."

It is not my purpose here to question or discuss these changes in strategy, but certainly those parts of the weapons research and development cycle which must precede field use by more than three or four years cannot be closely geared to the momentary needs of our strategic policy.

In the event of a sudden change in strategic requirements, it is, of course, possible to set up "crash" programs to provide what is needed in four or five years instead of the seven to ten years which characterize most weapons development. Such programs, however, tend to be wasteful of manpower and money, usually at the expense of other necessary programs, which are consequently delayed.

"Crash" programs probably always will be with us for the reason that there will always be unexpected technical and political developments, but this fact is hardly any justification for building them into the system as standard operating procedure. If "crash" programs are to be effective in meeting real emergencies, there cannot be too many of them.

This implies that regardless of our current views on limited war versus general war, on foreign bases versus Fortress America, or on nuclear versus nonnuclear war, a substantial amount of applied research and exploratory development ought to go into areas appropriate to each of these situations.

There has been much debate on the proper ways to administer and perform weapons research and development. There are some who argue that control of weapons research and development should be turned over to a new Government agency staffed by civilian scientists and administrators. There are those who argue that much more of the work should be done by the military in their own laboratories. Last but not least are those who argue that all research and development should be left to industry with a minimum of interference from either civilian or military Government officials.

While the merits of one approach or another can be argued *ad infinitum*, history does not indicate the outstanding virtue of any one of these. The debate is not new; it goes back practically to the beginnings of our country.

When Eli Whitney obtained his first contract to produce muskets for the Federal Government, there was considerable public sentiment to the effect that this should all be done in Government arsenals. Actually, both Whitney and the arsenals produced muskets and both made their contributions to the Nation's military and industrial strength.

CIVILIAN scientific groups are far from infallible in planning research and development. Frank Whittle, himself an officer of the Royal Air Force, received no aid or comfort from either the Royal Air Force or the civilian scientific boards when he first began his attempts to develop the jet engine. Neither did the aircraft engine industry in any country show sufficient vision and foresight in its applied research and development program to make substantial contributions to the early phases of jet-engine development. The eminent astronomer Simon Newcomb "proved" that the airplane was impossible only a few weeks before the Wright brothers first flew.

While there have been some singularly good examples of military-civilian cooperation in advanced research and development, the record of the military here is not as good as it might be. The United States Army did not welcome the airplane nor hasten to capitalize on its potentials. The United States Navy did not welcome the submarine. The United States Air Force is of too recent an origin to provide such obvious examples, but it has been apparent since World War II that some of its old-line flying officers have gone along with missiles and space programs about as willingly as some of the old-line admirals went along with airplanes and aircraft carriers in an earlier era. I am throwing stones, not because I am without sin, but to point out we are fallible and have all made these mistakes.

THE truth is that no group is omniscent and no one group has a monopoly on myopia. Even the pure scientists who might be expected to be highly receptive to new ideas are far from optimum in this respect. To quote Max Planck, the discoverer of the quantum theory of radiation: "A new scientific truth does not triumph by convincing its opponents and making them see the light, but rather because its opponents eventually die and a new generation grows up that is familiar with it."

The obvious solution is, I am afraid, a somewhat unpopular one. It is that we continue to perform our research and development with a diversity of independent groups in government, industry, universities, and scientific institutions, with somewhat overlapping functions. On the surface, this may seem like a highly unorganized process, and we have been led to believe that only basic research is allowed to be unorganized, but it hardly can be argued that the line between basic and applied research is so rigorously defined as to permit a clear distinction. There are no sharp discontinuities between the two.

Often the basic scientist will be willing to carry his brain children a part of the way toward application, and just as often the engineer will be willing and anxious to help resolve some

of the fundamental questions which bedevil his progress toward practical objectives. The very diversity of the people and organizations engaged in the research and development cycle will perform a very essential service in providing for continuous communication between the basic and applied scientists, and between the scientific groups and the military planning and using groups.

Paralleling the need for diversity in the applied research and development team is a need for diversity of sponsoring sources. We are talking here about who pays the bill and who decides what to buy. There are many who hope that the new Director of Research and Engineering in the Department of Defense will be a czar who will tightly control the performance of research and development under a unified plan. This is an attractive idea, since it brings visions of elimination of duplication and savings in costs which everybody would like to have. Such an approach to the management of research and development implies that there is some clear-cut way of deciding just what should or should not be done.

The history cited above and multitudinous other examples show that this probably never will be the case. There are many instances in which one or another service set itself dogmatically either for or against some line of development.

The Navy once made a technical decision that helicopters with militarily useful load capacities probably never could be developed, and abstained from taking any part in helicopter development until quite far along in the cycle. Fortunately, the Army thought differently.

IN the 'thirties the Army decided that the wave of the future in aircraft engines lay in the liquid-cooled variety, but the Navy stepped into the breach and continued the development of new and more powerful air-cooled engines which served important needs in World War II.

It is interesting to note that the Army's ballistic missiles are powered by versions of Air Force rocket engines and that the latest Air Force ballistic missiles employ an ablating nose cone which was first developed by the Army for the Jupiter missile.

These cases point to the virtue of a certain amount of duplication in our research and development programs. This is by no means an argument for duplication in production of parallel weapon systems or for duplication of service functions, nor is it an argument for participation in all areas of research by all agencies. However, in an age when we can afford to have a choice of two dozen makes of automobiles and many dozen brands of soap, it is rather strange that some of the firmest adherents of competition believe that there should be only one brand of research and development.

IF this looser system which is being advocated here results in a certain amount of duplication, who is to say that this is bad? Those who are concerned with weapon-system development know that a certain amount of redundancy in the critical components can greatly increase the reliability and effectiveness of a weapon system.

Similarly, substantial overlap in applied research areas covered by the various Government agencies, military and civilian, can be a very healthy thing and is, in the more advanced areas, a necessary thing.

An applied research and development program which is suitably forward-looking will engender a certain number of failures. If no failures are evident, it is almost certain evidence that our program is not bold enough or aggressive enough. Failure to accomplish a given objective does not mean that work done toward that objective is of no value—it often results in the enlargement of technology and the development of components which can be directed usefully toward other objectives.

Nonetheless, the failures will not thereby become successes, and it is necessary that failures be accepted as part of the game. For if we wait until we can be sure of success, we will, in many cases, have waited too long. A great deal of public education is necessary before general acceptance of this idea can be expected, but it is essential to a good national research program.

The details of administration and control of the weapons research program now consume ridiculously large amounts of the time of many of our best research people. The National Science Foundation in a recent report concerned with research and development at university and nonprofit institutions, stated:

"Given the very best of intentions, supply and procurement contracting officers whose major volume of business occurs in the 'hardware' area cannot be expected to handle research contracts with the same facility as officials who have dealt primarily with research matters over a span of years."

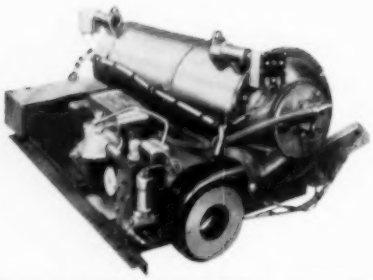
I would like to make it clear they were not talking about basic research, but research and development, and particularly the early stages where the line between basic research and application is very thin.

THE foregoing quotation is simply a recent repetition of a conclusion previously reached by almost every group which has studied the problem of the administration of research and development contracts, and it is by no means restricted to university contracts. Yet in most cases research and development contracts by the armed services are administered under the same general regulations by essentially the same group of people as are involved in "hardware" contracts.

Just this year the House Committee on Government Operations called for the establishment of new contracting arrangements suitable for research and development. There is considerable evidence that Congress, if given a clear indication of what is needed in the area of research and development procurement legislation, would attempt to provide it. This calls for immediate concerted action by the military, assisted by leading scientific and industrial people, if anything is to be done soon.

Finally, the question of costs must be faced. Many of the suggestions which I have made imply the need for additional funds, even within the framework of the presently contemplated program.

Our civilian economy, as well as our military defense, depends to an ever-increasing degree on scientific and technical advances. Exploitation of these advances to the utmost, all the way from basic research to production, not only will provide the military strength we need but will also provide just the sort of basis for expansion of product and service lines upon which our civilian economy thrives.



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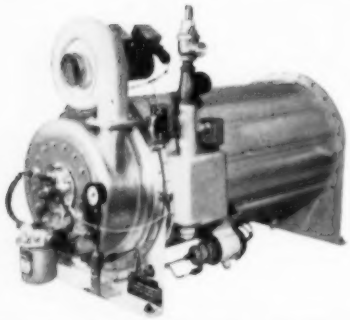

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LET'S COUNT BACK FROM THE COUNTDOWN

This is the "moment of truth." This is the countdown. A satellite will soar into the stratosphere. A rocket will hit or encircle the moon.

But let's count *back* from the countdown.

Let's count the grueling tests, the check-outs. Let's count the months of manufacturing, the skill, precision and care that went into each of the thousands of parts.

Let's count the brain-power, the engineering talents of the brilliant men at work . . . the modifications and refinements in design . . . the "breakthroughs" that had to be made.

Let's count all the way back to the first gleam of concept in a scientist's probing, inventive mind.

And let's not forget to count the administrative control, the guidance, the coordination and planning that go into these complex projects.

There's a new name for it

Such involved systems of engineering and automation demand an entirely new concept of planning, research, specialized administration and technical coordination. It is called "system management." It places complete responsibility for every phase of a giant project in the hands of one company or group of companies.

It takes tremendous resources. In manpower. In administrative capacity. In facilities. And that is why ITT has been selected for projects of the highest importance. The ITT System operates and maintains the DEW Line, and is managing the production of a new world-wide electronic control system ingeniously conceived by the Strategic Air Command for its operations.

And ITT is deep in many other vital projects.

In industry, too, there are "countdowns"

Large industrial projects, too, need system management. Vast communication networks, for instance . . . linking continents through "over-the-horizon" microwave . . . world-wide air-navigation systems . . . the development of automation in industrial processes.

System management has great potential. And ITT is equipped to put it to work . . . to assume full responsibility for complete system management projects anywhere in the free world. This includes not only basic concept, engineering and manufacture . . . but also installation, testing, operation and maintenance.

You can count on ITT . . . from concept to countdown.

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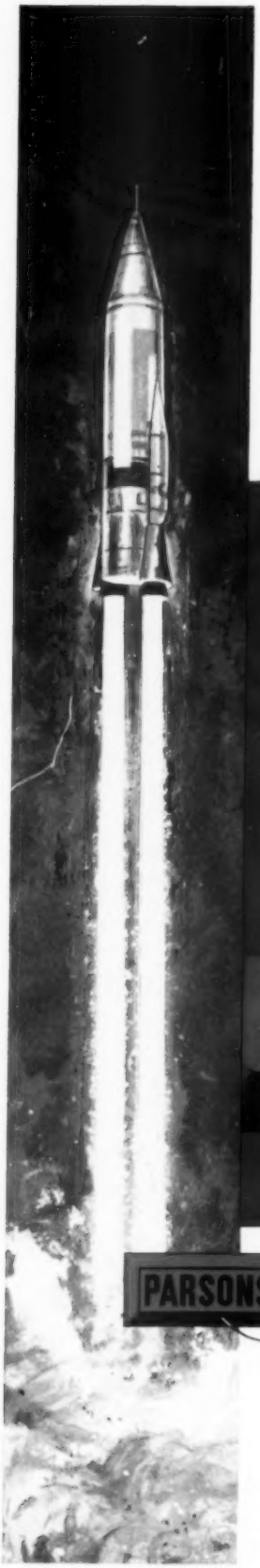

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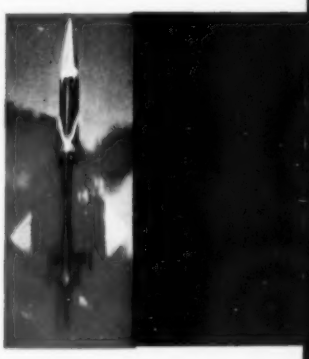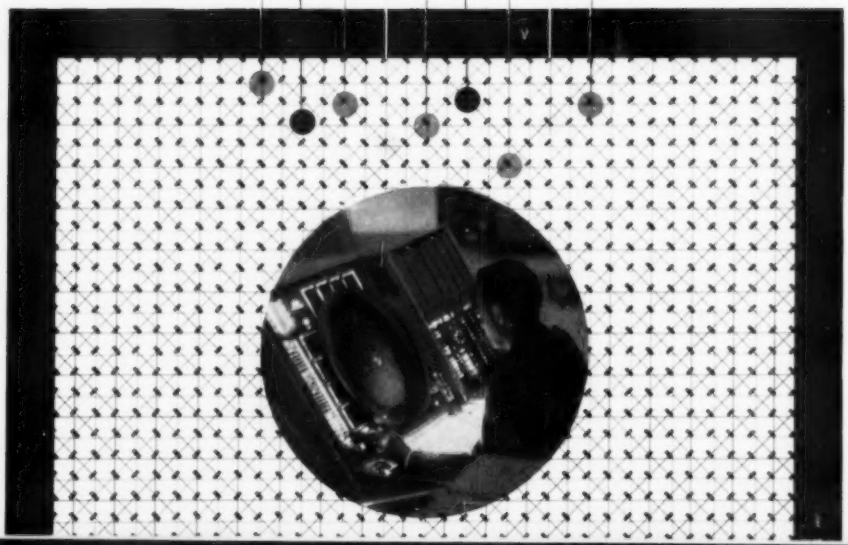
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